ERDAS Customer Education

Introduction to the ERDAS IMAGINE® Developer's Toolkit

erdas
The Earth to Business Company

Introduction to the ERDAS IMAGINE Developers' Toolkit

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About This Manual

This manual is an instructional document, designed as the second half of a 2 part course. This course covers the implementation of sensor models within the ERDAS IMAGINE and LPS environment. All topics on the theory of sensor modeling are covered in the first part entitled ‘Theory of Sensor Modeling’. This course may also be used as a stand alone course for students who already familiar with the concepts and theory of sensor modeling. Students are required to be familiar with the ERDAS IMAGINE Developers’ Toolkit™ and to have previously attended the training course on this offered be ERDAS Customer Education.

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Welcome to the IMAGINE Developers' Toolkit™

The IMAGINE Developers' Toolkit™ is a set of libraries and documentation for ERDAS IMAGINE® users who wish to modify the commercial version of the software or develop entirely new applications to extend the capabilities of the software to meet their specific project needs. The IMAGINE Developers' Toolkit includes a set of C/C++ language APIs that are intended for the experienced C/C++ programmer. This course describes the modifications and new applications that may be developed using the Toolkit.

ERDAS IMAGINE is a broad suite of software products designed to address the needs of a wide audience. Although the user interface is designed to make workflows easy for a variety of skill and experience levels, some organizations need to customize the software in order to streamline a particular production workflow. The basic customization capabilities of ERDAS IMAGINE are particularly well suited for modifying the easy-to-use graphical interface, while the IMAGINE Developers' Toolkit is designed primarily for users needing to tailor the software beyond this level.

Using This Manual

Introduction

This IMAGINE Developers' Toolkit™ Exercise Manual contains step-by-step instructions on how to perform certain processes. You should be aware that each exercise provides a single path through ERDAS IMAGINE® tools. In most cases, there are various ways to maximize tool usage, depending upon the individual project.

This exercise manual is provided to the student, along with all images, and copies of the presentation slides used by the instructor. This provides the capability for recreating the processes performed in class at a later date.

The Exercise Conventions

Section Page	States the objective of the exercises and lists the application tools to be utilized within the exercises.
Exercise	Each exercise consist of background introduction, package introduction and code snippet. You can find the code snippet on the CD.
Questions	These appear in a slightly larger font size, using bold and italics. The instructor may quiz you about them following each exercise.
Class Notes	These pages for your class notes are found at the end of each exercise.

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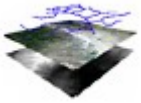
Notational Conventions

Bold Italicized Text	Any text, which is bold, indicates a ***filename***, or **parameter** to be changed or selected.
Graphics	To help you locate icons and objects used in the exercises, the icons will be next to the icon name in the text.
Insets	These italicized captions will appear in the outside margin of the page. They define terms or explain theory behind the steps you are being asked to perform.
Diagrams	These are optional means to direct you in the usage of some of the application's tools.

The following graphics are also used for particular purposes:

*This is a **note** or a quick tip. It gives additional relevant information, or describes other ways of using the software.*

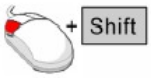


*This is information relating to the **application** of the current tools.*

*This is a reference. It provides **additional theory or science** that will help in using the tools.*

*This is a **warning**. It cautions you regarding potential pitfalls and how to avoid producing errors.*

Mouse and Keyboard Conventions

	LMB	Left mouse button
	MMB	Middle mouse button
	RMB	Right mouse button
	**LMB + Shift**	Hold down the Shift key plus left mouse button

Section 1: Introduction to IMAGINE Toolkit

Section objective:

This section describes the IMAGINE Developers' Toolkit and outlines what the IMAGINE Developers' Toolkit include. It also introduces the different levels of customization, for IMAGINE, which make up the framework of this traning book. This manual will start off with very basic levels of customization and move into advanced levels of IMAGINE customization.

What is IMAGINE Developers' Toolkit

What does IMAGINE Developers' Toolkit Include? The IMAGINE Developers' Toolkit is a set of libraries and documentation for ERDAS IMAGINE users who wish to modify the commercial version of the software or develop entirely new applications to extend the capabilities of the software to meet their specific project needs. The new applications and jobs can be seamless integrated into the IMAGINE environment.

Note: *Throuout this document the "IMAGINE Developers' Toolkit" will be refered to as "Toolkit" for abbreviation.*

Toolkit libraries are organized into several large functional packages. The core is the base library, called **erasterlib** (ERDAS Raster Library) contains all the core functionality needed to create/read/write geospatial imagery. Layered on the top of this is **elib** (ERDAS library), which contains all of the non-GUI components of application creation such as session management, annotation I/O, and a number of utility packages. Layered on top of the **elib** library is the user interface library, called **emllib** (ERDAS Macro language Library), which contains all the functions for creating a portable GUI and interfacing with EML.

Where to find help? Customers who have purchased software maintenance for the Toolkit will be granted access to the **ERDAS IMAGINE Toolkit Developers' Network** (http://developer.lggi.com). This network is an online, interactive tool used to present the most up to date documentation and examples for Toolkit API. It also provide code forum for Toolkit user community all over the world.

All content in this environment is shared by Toolkit customers and ERDAS employees makeing this a true network of programmers. This method for sharing Toolkit documentation to every Toolkit programmer insures that all content in the network is as up-to-date as possible. This web environment includes:

1. a Toolkit Library, which contains documentation for all supported Toolkit Packages, Data Types, and Functions. All entries are categorized for easy searching.
2. a Developers' FAQ section (i.e., Knowledge Base). This is a list of commonly asked customer questions with answers provided by ERDAS employees.
3. Each item in the Toolkit Library Database is dynamically linked to every example. This means that when selecting a particular function or data type, a list of example program containing that item will be returned.
4. Each user will be able to download the complete project from the Example database.
5. A coding forum is included , allowing customers to ask other developers questions on any developer-related topic. Customer can subscribe to coding forums so they can receive notification when answers are posting to the forum.

Any requirement for IMAGINE Developers' Toolkit? User of the IMAGINE Developers' Toolkit must be an experienced C programmers. The Toolkit support is offered as a separate package designed specifically to meet the needs of developers. Access to download content from the IMAGINE Toolkit Developers' Network is only available to those customers with a current software maintenance contract.

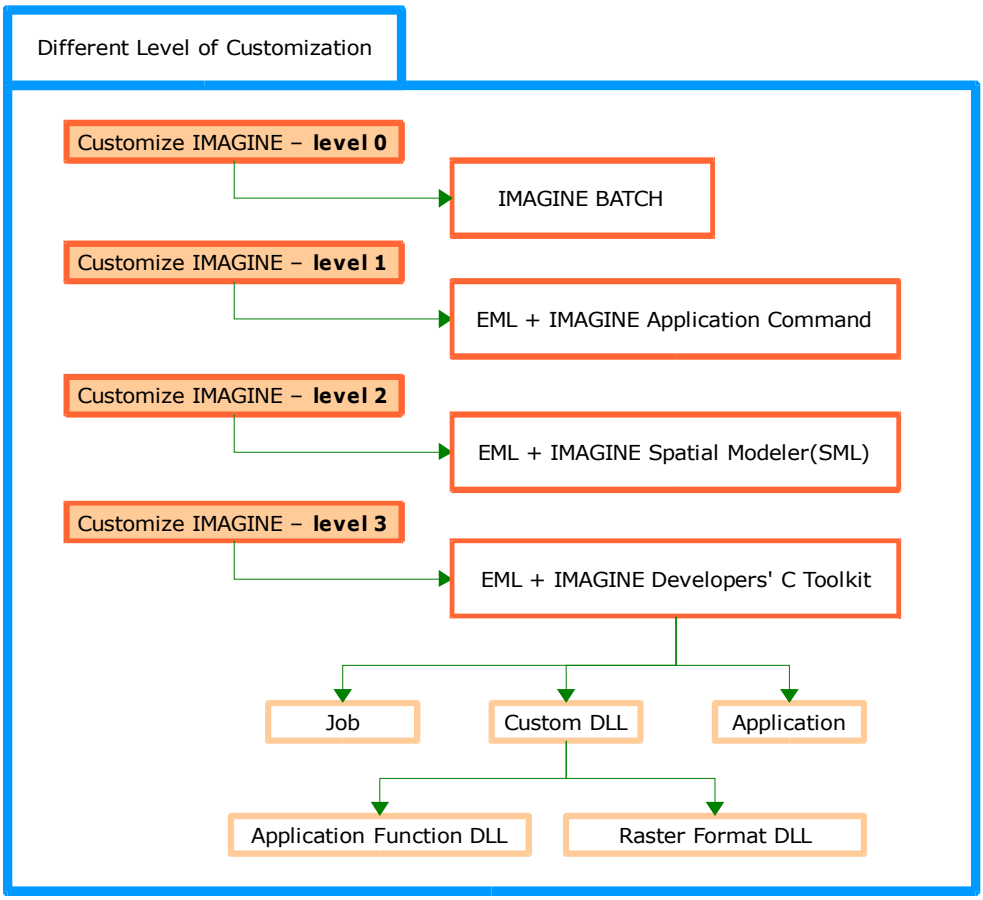
Note: IMAGINE Developers' Toolkit v9.1 need to be installed on a machine with IMAGINE v9.1 Professional already installed.

Different level of customization for IMAGINE

ERDAS IMAGINE is a broad suite of software products designed to address the needs of a wide audience. Although the user interface is designed to make workflows easy for a variety of skill and experience levels, some organizations need to customize the software in order to streamline a particular production workflow.

The basic customization capability of ERDAS IMAGINE can be done by using IMAGINE Preference Editor, which is particularly well suited for modifying the easy-to-use graphical interface. Toolkit is designed primarily for users needing to tailor the software beyond this level.

What type of customization/modifications do you need to make? This is the most important question in determining which ERDAS IMAGINE tools you will need to use. The following figure shows different levels of customization for ERDAS IMAGINE, you can choose different level of customization based on what you need to achieve.



IMAGINE BATCH (**level 0**) is a very convenient way to streamline your workflow. Most ERDAS IMAGINE tasks can run in the BATCH mode, there is a Batch button in the processing dialog. This is useful if you have a process that requires a long time to run and you want to run it when your system is at minimum utilization (for example, during the night). It is also useful if you wish to run a repetitive task many times, such as executing the reprojection command to reproject hundreds of images. If you are familiar with DOS (simulated under Windows) programming, you can write your own DOS batch file, and

run it without opening ERDAS IMAGINE. Basically IMAGINE BATCH will eventually call IMAGINE Application Command, so check IMAGINE documentation for more details (IMAGINE Online help->Appendices->Applications Commands->Alphabetical Index)

EML + IMAGINE Application Command (**level 1**) will provide you a GUI user interface, which is developed by EML (ERDAS Macro Language). EML comes with every license of the IMAGINE software. This language is a scripting language that can be used to define the structure and content of the user interface, as well as provide some fundamental procedural scripting capabilities. Each script is interpreted at application startup and converted into instructions for the native windowing system (i.e., EML user interface constructs are converted to Motif under UNIX and Win32 under Windows). These files are just copied to the IMGINE_HOME\scripts directory for runtime. Each script is an ASCII (American Standard Code for Information Interchange) file, which may be edited to change its contents.

EML + IMAGINE Spatial Modeler (SML) (**level 2**) will add new capabilities to the IMAGINE software instead of customizing the existing applications. IMAGINE Spatial Modeler is a component of both IMAGINE Advantage and IMAGINE Professional licenses. Once you have developed a new algorithm using the graphical Model Maker environment, you can generate SML (Spatial Modeler Language) script. The best example to demonstrate the capability of SML is Image Interpreter in ERDAS IMAGINE; Image interpreter is built primarily from SML script with an EML interface. The new application may be plugged into the existing ERDAS IMAGINE menu/toolbar structure so that it functions like any other part of the system.

EML + IMAGINE Developers' C Toolkit (**level 3**) will provide I/O for the ERDAS IMAGINE file format, as well as functions that make it easier to create an importer/exporter that operates like those that ship with ERDAS IMAGINE. While the SML language provides over 100 built-in functions spanning many types of image processing and spatial modeling functions, there are always new developments underway. With IMAGINE Developers' C toolkit, programmers can create new types of geographic imaging applications and access many types of imagery through a single interface, as well as deal with many issues such as resampling or caching. New algorithms developed in the IMAGINE Developers' toolkit can be integrated into the ERDAS IMAGINE user interface, just like all other ERDAS developed applications.

Toolkit is often used to create JOBs, Custom DLLs and Applications.

- **JOB**

A JOB is the simplest way to use Toolkit. It works like other IMAGINE Application commands.

- **Custom DLLs**

A major feature of the ERDAS IMAGINE architecture is the use of **DLLs** to provide for custom extensions. A DLL is a Dynamically Loadable Library, which is a piece of code to be located and used at run time by an application. For example, without modification to existing applications, a Raster Format DLL may be written and added to the system, which allows all ERDAS IMAGINE applications to access data stored in previously unsupported file format directly and without file conversion.

Another example is Application function DLLs, which can extend EML built-in functions.

The reason we call a custom DLL a Dynamically Loadable Library is because:

1. The DLL (Dynamically Loadable Library) itself is just a binary file, which is similar to DLLs (Dynamically Linked Library) generated by Microsoft Visual Studio.

2. The difference between a Dynamically Loadable Library and a Dynamically Linked Library is the Dynamically Loadable Library is a, not linked time library. While a Dynamically Linked Library is a linked time library.

If your program needs a DLL (Dynamically Linked Library) called A.dll in order to start, your program will crash if the A.dll doesn't exist (i.e., your program will search for A.dll at linked time).

If you have a raster format DLL (Dynamically Loadable Library) e.g. YourFormat.dll, for IMAGINE, IMAGINE will not crash if YourFormat.dll doesn't exist.

- **Application**

The IMAGINE Toolkit Application offers user interaction capabilities, which allows the user to interact with the IMAGINE Viewer and CellArray by using your mouse.

In summary, you may choose different tools for different tasks, IMAGINE Toolkit provides you maximum flexibility and the power to customize and extend ERDAS IMAGINE.

Do not use undocumented structures or functions. Also, do not use functions designed for JOBs in applications, or functions designed for applications in JOBs.

Class Notes:

Exercise 1: Add an Icon to IMAGINE

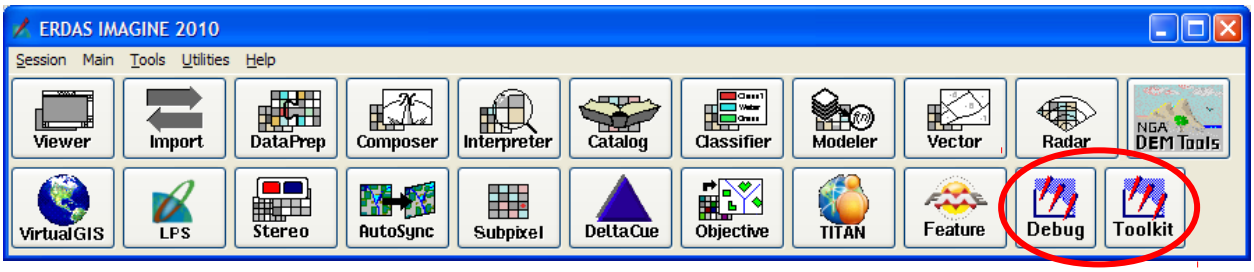
Exercise Objective:

This exercise will instruct you on how to add your own IMAGINE icon to the IMAGINE icon panel.

Add your own Icons to IMAGINE

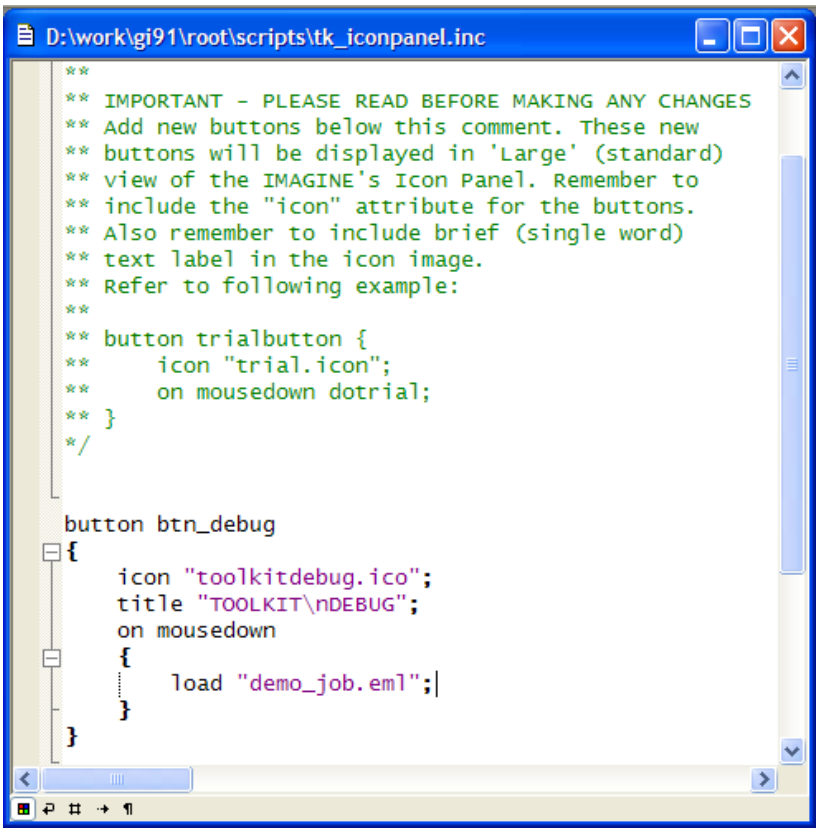
Are you tired of typing "***load *.eml***" from the command line when you debug EML Scripts? You can load your eml script by clicking an icon button found on the IMAGINE icon panel. This will save you time when debugging.

The IMAGINE icon panel looks like: (**NOTE**: this classic interface is only available to IMAGINE 9.x and 10.x)



Notice the last two icons are created during this training class.

When you create a new user interface in EML, you will typically want to access this script via the IMAGINE icon panel. To do this, you must create a custom version of IMAGINE.eml and modify it. One approach you might choose is to add a button to the iconpanel frame that loads your custom EML script. Note that just as the load command can be used in the Commands dialog to display custom EML GUIs, this command can also be called from a button in the iconpanel. Fortunately there is an easy way to do this, you can copy **<IMAGINE_HOME>\scripts\tk_iconpanel.inc** file to **<IMAGINE_HOME>\scripts\ntx86\tk_iconpanel.inc**, and add your icon button by following the instructions included in the file.



For example, In next section you will create a new EML script named "***demo_job.eml***", which takes an input image and convert it to JPEG2000, you can add the following button to the IMAGINE icon panel:

```
button btn_debug
{
     icon "toolkitdebug.ico";
     title "TOOLKIT\nDEBUG";
     on mousedown
     {
          load "demo_job.eml";
     }
}
```

The button should be identified in a meaningful way. All of IMAGINE's icon panel buttons, are labeled using icon files. You may not always have the appropriate icon files for new buttons and therefore you should have a proper "title". In the above example, we see "**\n**" between the words "TOOLKIT" and "**DEBUG**". The "**\n**" introduces a line break between the two words and prevents the title string from running off the edge of the button. When you use a text button instead of an icon button, in the icon panel, you must use the "**geometry**" key word (explained later in this course) so that the button will have the same size and shape as the rest of the buttons on the panel.

Also, by using the load command in the "**on mousedown**" message handler the need to load this EML script manually, from the commands dialog, is eliminated.

Note: *You should always add a title to an icon button, even if the title doesn't display. By doing so, an un-existing ico file can always be replaced by a meaningful title.*

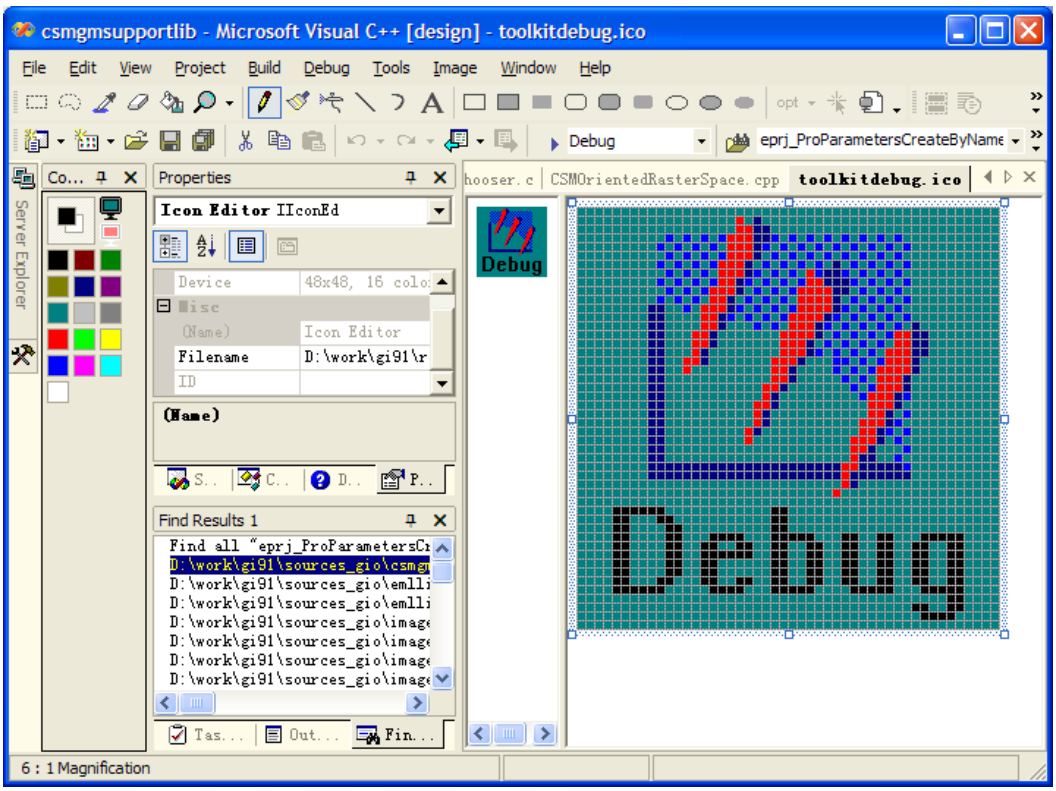
Note: *If you choose the "Small Icons" from "IMAGINE Preference->Icon Panel Display Options", you need to edit <IMAGINE_HOME>\scripts\ntx86\tk_iconpanelsmall.inc.*

The ***tk_*.inc*** files are created during the installation of IMAGINE Toolkit, while the ***spt_*.inc*** files are installed during the IMAGINE installation. Although these files are created by different installers they basically have the same functionality.

Make Your Own Icons (*.ico)

You may use Microsoft Visual Studio to create your own icon file. Microsoft ICON files can contain multiple sized ICONs in one single file. When creating an ICON for IMAGINE make sure there is only one size, i.e. 48 x 48 pixels. If you put 2 different size (e.g., 32 x 32 pixels and 48 x 48 pixels) in one ICON file, IMAGINE will use the smallest icon which in this example is 32 x 32 pixels.

The following figure shows the ICON editor in Microsoft Visual Studio:



Class Notes:

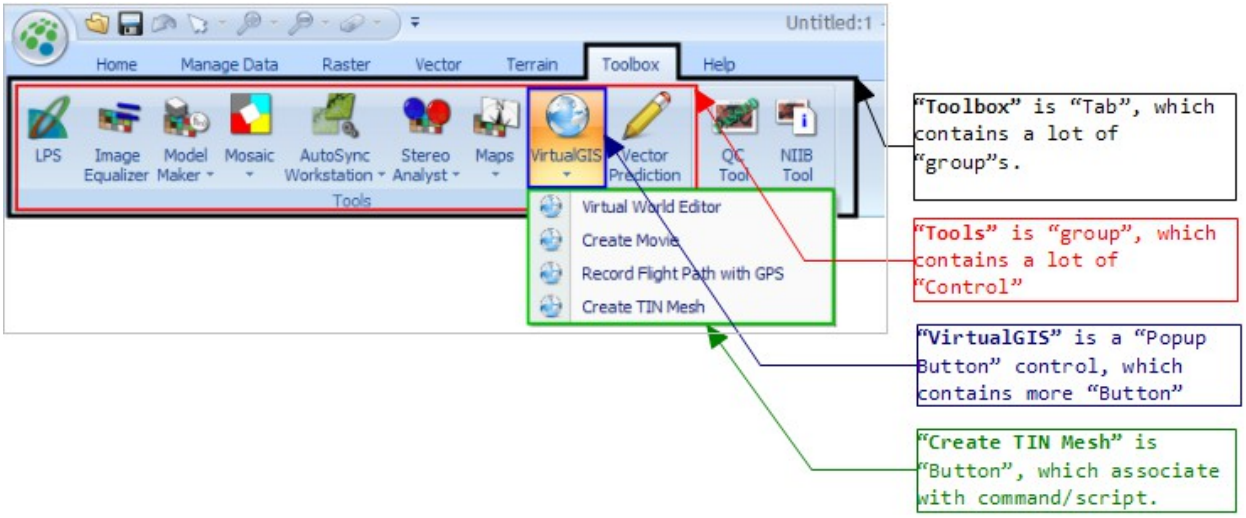
Exercise 2: Add Button to IMAGINE Ribbon

Exercise Objective:

This exercise will instruct you on how to add your own IMAGINE button to the IMAGINE Ribbon.

Add your own button to IMAGINE Ribbon

The Ribbon is divided up into Tabs, Groups and Controls. Multiple tabs make up the Ribbon; multiple groups make up a Tab; multiple Controls make up a Group. Further, Controls may have various styles, such as “Button,” “Popup Button,” and so forth. For example, the follow diagram shows the basic setup for ribbon.



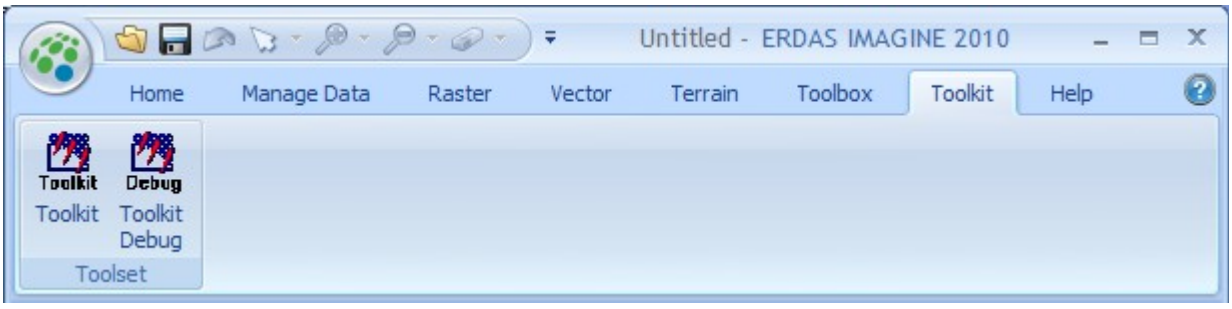
In order to add your tab, group, and control, you need to add the following folder and xml files to **<IMAGINE_HOME>\etc\toolbox** folder:

```
<IMAGINE_HOME>\etc\toolbox\
                          |_toolkit.tlbx
                          |_toolkit\
                               |_toolset.tlbx
                               |_toolset\
                                    |_btn_toolkit.tlbx
                                    |_btn_toolkitdebug.tlbx
```

Here are the xml files (*.tlbx) you need to create:

Toolkit.tlbx “Tab”	<?xml version="1.0" ?> <TLBX start="false"> <name>Toolkit</name> <type>Tab</type> <command> <category>ToolBox</category> <name>Toolkit</name> <type info="toolbox\toolkit">Folder</type> <order>250</order> </command> </TLBX>
Toolset.tlbx “Group”	<?xml version="1.0" ?> <TLBX start="false"> <name>Toolset</name> <type>Group</type> <command> <category>ToolBox</category> <name>Toolset</name> <type info="toolbox\toolkit\toolset">Folder</type> <order>50</order> </command> </TLBX>
Btn_Toolkit.tlbx “Control”	<?xml version="1.0" ?> <TLBX start="false"> <name>Toolkit Tool 1</name> <type>Button</type> <controlStyle>IconAndCaptionBelow</controlStyle> <command> <category>ToolBox</category> <name>Toolkit</name> <type info="demo_job.eml">Script</type> <icon>Toolkit.ico</icon> <help></help> <order>50</order> </command> </TLBX>
Btn_Toolkitdebug.tlbx ‘Control”	<?xml version="1.0" ?> <TLBX start="false"> <name>Toolkit Tool 2</name> <type>Button</type> <controlStyle>IconAndCaptionBelow</controlStyle> <command> <category>ToolBox</category> <name>Toolkit Debug</name> <type info="viewer create at 0 0 size 400 400">Executable</type> <icon>Toolkitdebug.ico</icon> <help></help> <order>50</order> </command> </TLBX>

The IMAGINE Ribbon Interface will look like this:



Section 2: Introduction to IMAGINE EML

Section objective:

This section studies the basic syntax of EML and the built-in functions and techniques used to design a good GUI. You will also learn how to call IMAGINE application commands from EML.

Introduction of EML

The ERDAS Macro Language (EML) is a script language for creating Graphical User Interfaces (GUIs) in IMAGINE. Virtually all IMAGINE interfaces from the IMAGINE icon panel to the IMAGINE Viewer have been constructed with this language. EML allows programmers and non-programmers alike to modify IMAGINE GUIs and create new GUIs of their own. In addition to its GUI building capabilities, EML features procedural capabilities that allow simple programming tasks to be achieved such as automatically naming an output file based on an input file name. Finally, EML is platform independent; that is, user interfaces designed on UNIX platforms can be transferred to PC platforms (Windows95/NT/XP) and vice versa. IMAGINE takes care of determining what the windowing system is on a particular platform and interprets the GUI elements in EML scripts accordingly.

When the designing of ERDAS IMAGINE began, it was clear that a traditional, static GUI would not meet the needs of the variety of users and applications of the ERDAS product line. Under static GUI structure, users would not be able to customize the interface and to create scripts which could be used to execute frequently used functions. The ERDAS Macro Language (EML) is the result of this design.

EML is designed to serve as a scripting language as well as a user interface language. Unlike simple user interface description tool (such as UIL in motif), EML is able to define the actions which are to be taken when a user interacts with a dialog. It provides a complete syntax for defining a typical dialog box, as well as constructs for defining scripts which contain branching and control logic.

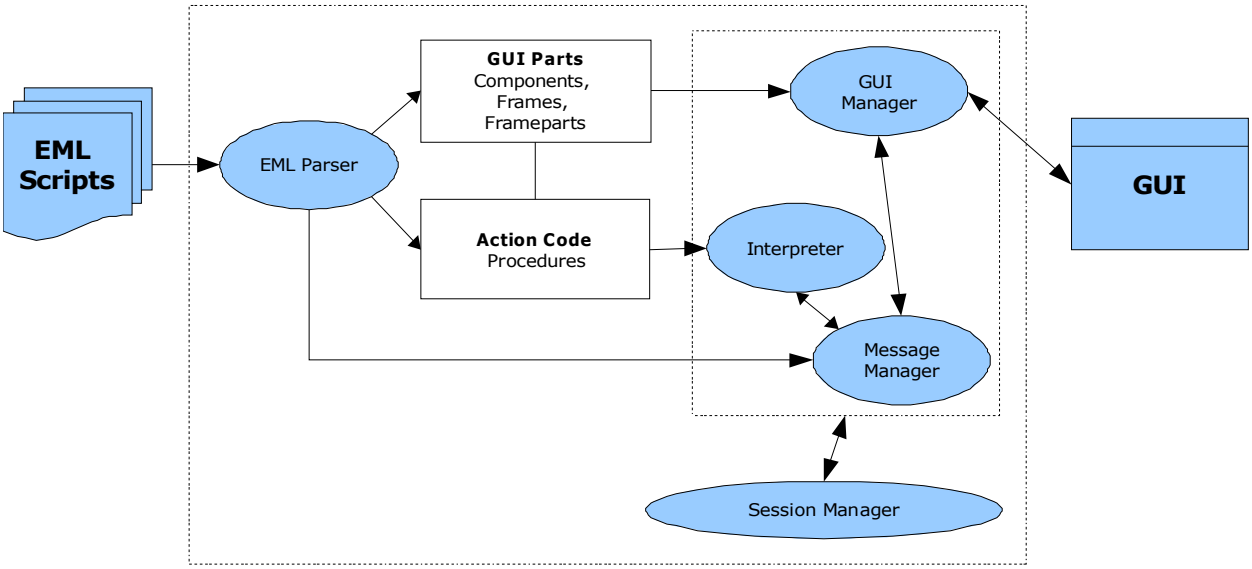
In addition to the macro language itself, EML provides a very good connection to Toolkit. Toolkit programmers can build the EML language into their toolkit application, and to extend the language through application specific variables, functions, and commands.

All ERDAS IMAGINE GUI interfaces are generated by EML, and ERDAS IMAIGNE itself is the best example of how to use EML scripts. You may find all of them in folder **<IMAGINE_HOME>\Scripts** . For example you may find the EML script for the IMAGINE Viewer at **<IMAGINE_HOME>\Scripts\viewer.eml**.

EML Architecture

EML is built from the following major pieces: the Parser, the Interpreter, the Message Manager, the GUI Manager, and the Session Manager. The following figure shows the EML Architecture.

EML Architecture



The Parser, Interpreter, and the GUI Manager:

EML scripts can be used to define both user interface elements and actions to be taken when a user interacts with those elements. The Parser reads EML script files and converts them into an internal form which represents the user interface and its associated procedures. The user interface definitions are handled by the GUI manager and the procedures are handled by the Interpreter.

The Interpreter: When a script is parsed, all of the GUI elements are converted into a tree structured representation in memory. The GUI Manager uses its internal representation to generate the user interface.

Each of the procedures is converted into an internal form which can be quickly evaluated by the Interpreter. The translation of the EML script into an internal form by the Parser allows an EML based application to perform at a level somewhere between that of a purely interpreted application and a purely compiled application.

The GUI Manager controls the creation and display of dialogs and the interpretation of user input. It is responsible for transparently adapting the EML dialogs to different systems, such as Motif or Windows NT.

The Message Manager:

EML relies heavily on the use of messages. When the user clicks on a button or selects an item, a message is generated and sent to the framepart to indicate what event has occurred. When a script is parsed, the “startup” message is sent to the EML component defined in that script so that any necessary initialization can be performed.

Messages can originate from several places. The most common place from which messages originate is the GUI manager which sends event messages in response to user actions. The second source of events is from within EML procedures.

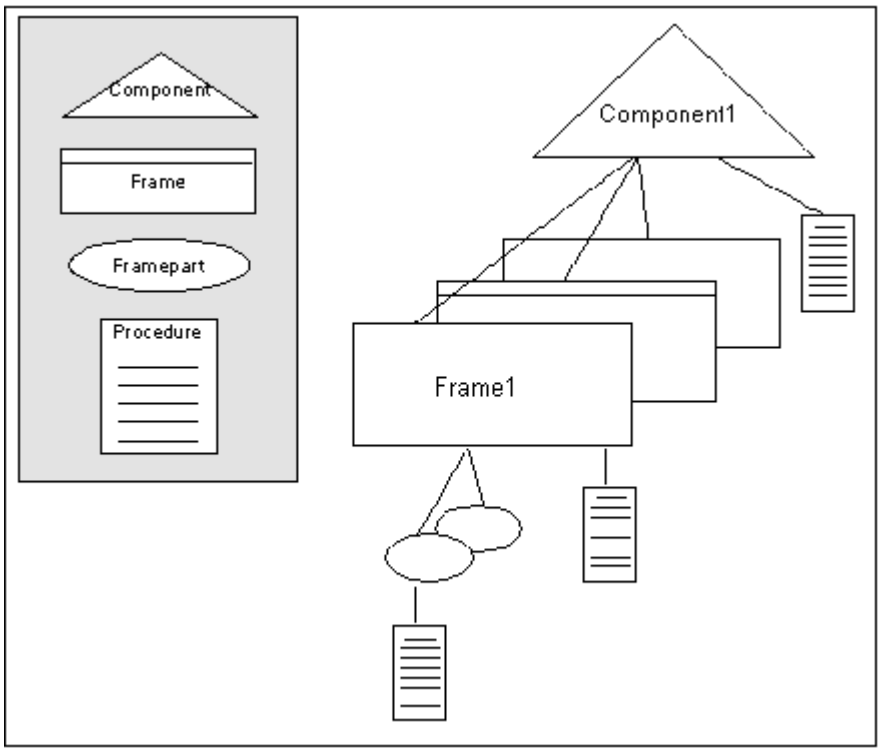
The Session Manager:
The Session Manager provides functionality for managing an IMAGINE session. This functionality includes global variable management, preference and configuration management, batch JOB management, inter-application communication; help system management, interactive command execution

and session log management. Many of these features are implemented by directly incorporating access to the features into the ERDAS Macro Language syntax and implementation. Therefore, the Session Manager is currently considered part of EML.

EML Script Structure

EML script consists of the following components: Components, Frames, Frameparts, and action code.

The following figure shows the basic structure of an EML Script.



Components:
All GUI elements in an EML script are contained in a Component. The component is simply a means of collecting one or more GUI objects into a single named group. The component can not be visualized; it is only an entry point of the EML script. Each EML script will only have one component, and the name of the component should be the same as the name of the EML.

Frames:
A Frame is a rectangular region which contains one or more GUI elements called Frameparts. In IMAGINE, Frames are used in one of two ways. They may be used as document Frames or as Dialog Frames.
A Document Frame displays information as an image, or as a model, which the user can edit.
A Dialog Frame provides a form with which the user interacts.

Frameparts:

Every frame is populated with one or more user interface elements. We interact with these elements as buttons, checkbox, meter bar, and text areas. Each framepart has a list of specific attributes which define it. There are many different kinds of Frameparts, and they are the key to building GUI's in IMAGINE.

Procedures (Action Code):
A Procedure is a block of one or more statements which are used to initiate, modify, or control an operation. Components, frames, and frameparts may all have procedures.

EML Script Structure in action

The most basic stand-alone EML script must contain the following elements:

A Component

For those familiar with programming, an EML component is somewhat similar to a main program. When IMAGINE loads an EML script, it is actually loading the component. Each EML script contains only one component. By loading the component, IMAGINE gains access to the GUIs it contains.

The basic syntax of a component is:

```
COMPONENT <scriptbasename> {
 }
```

Note that the component must be assigned a name and curly brackets are required to open and close the component. The component name should always be the same as the root name of the EML script. So if the name of your script is "**myscript.eml**", the name of the component should be **myscript**. You must observe this rule to avoid confusing the IMAGINE session manager. By matching component names to unique script file names, you avoid potential problems.

A Frame

An EML frame is a window that stores one or more user interface objects such as buttons or menus. All GUIs developed with EML must contain a frame in order to interact with the user. All frames must be enclosed in the script component. Otherwise, IMAGINE cannot access them.

The basic syntax of frame is the same as that for a component:

```
FRAME <framename>{
}
```

Just as the component, each frame must be assigned a name. While an EML script will only contain a single component, a component can contain several frames. Each frame name within a given component must be unique. Finally, each frame must be opened and closed with curly brackets.

A GUI Part which allows the user to unload the script (the unload command)

All EML scripts must provide a mechanism for removing the component from the IMAGINE session. This is because the IMAGINE session cannot load the same script twice. Thus, the only way to be able to use an EML script more than once in a single session is to provide a mechanism for removing the script when we are finished using it. The EML command, "**unload**", must be issued in order to remove an EML script from the session manager.

The typical mechanism for unloading an EML script is a button framepart. In stand-alone EML scripts, all button frameparts must contain a mousedown message handler. Whenever a user clicks on a button in an IMAGINE GUI, a "**mousedown**" message is sent. The **mousedown** message handler (on **mousedown**) tells the session manager what to do when this message is received. In the case of a button that is used to remove an EML script from the session manager, the **mousedown** message handler must issue the **unload** command so that the session manager knows to remove (or "**unload**") the EML script.

This is the basic syntax for a button which servers to unload an EML script:

```
BUTTON <buttonname> {
     ON MOUSEDOWN {
          UNLOAD;
     }
}
```

The button framepart must be contained in a frame. Each frame can have several button (and other) frameparts. Each framepart must be named. The name must be unique and, by convention, a framepart name should indicate its purpose. Each framepart must be opened and closed with curly brackets. While not always required, message handlers such as "**on mousedown**" must often be opened and closed with curly brackets. Thus, it is a good practice to always open and close them in this way.

A Startup message handler (the display command)

Whenever an EML script is loaded in an IMAGINE session, the **startup** message is issued. A **startup** message handler must be included in all stand-alone EML scripts so that the GUIs contained in the script frames can be presented to the user. Without providing a **startup** message handler, the EML script has no means of interacting with the user.

In order to present a GUI to the user, the startup message handler (**on startup**) must issue the display command. The syntax of the display command is:

```
DISPLAY <framename>;
```

The frame displayed by the startup message handler must contain an interface object such as a button framepart that allows the user to unload the frame. (See above.) The basic syntax for a startup message handler is:

```
ON STARTUP {
     DISPLAY <framename>;
}
```

The **startup** message handler should appear at the end of the EML component. It must be defined inside the component but outside any frames defined in the script.

Now let's look at an example of the most basic type of EML script. We will use this example to provide context for the above descriptions and to look at some optional features not described in the basic syntax information provided thus far.

Modifying the EML scripts that comes with IMAGINE

EML not only allows you to create new user interfaces, it also allows you to modify some of the user interfaces that come with IMAGINE. Among these are the user interfaces that appear in "imagine.eml". Before you begin to edit any of the EML scripts provided by ERDAS, you should follow the appropriate procedures. If you observe these procedures, you will avoid potential problems.

1. **Never** edit the versions of these scripts found in **<IMAGINE_HOME>\scripts**

The correct procedure is to copy the script you wish to modify into a custom directory. Edit this new copy of the script. If you fail to observe this guideline, and edit the script in **<IMAGINE_HOME>\scripts**, you may end up having to reinstall IMAGINE because you have inadvertently introduced bugs into the script. In addition, you are preventing users from accessing the standard version of IMAGINE. This is especially problematic when your edits simplify the functionality of the interface. Again, editing the wrong version of the file would mean you would need to reinstall IMAGINE to regain the lost functionality.

2. Copy your version of the EML in to **<IMAGINE_HOME>\scripts\Win32Release**…

Stand-alone EML vs. Application-bound EML

This manual will focus mainly on what we will call **stand-alone** EML scripts. These scripts are loaded into a running IMAGINE session via the Commands dialog or via another EML script. They differ from what we will call **application-bound** EML scripts. Application-bound EML scripts are loaded into the IMAGINE session by C application programs. They are not fully functional unless they are loaded in this way (Hence using the term application-bound). In order to create a new application-bound EML script, you must write a C Toolkit application program. We will learn more about application-bound EML script in Section 7.

In this section, we will focus primarily on **stand-alone** EML scripts.

How do I know whether an EML script is application-bound?

Because extra caution must be taken when customizing IMAGINE EML scripts that are application-bound, we will provide some guidelines for determining whether the script you wish to modify is application-bound. The guidelines are:

1) If a script contains a generic framepart, it is definitely application-bound. However, not all application-bound scripts contain generic frameparts. So the absence of a generic framepart indicates nothing.
2) If a script does not contain an on startup message handler, it is definitely application-bound. But some application-bound EML scripts do have on startup message handlers. So the presence of this message handler indicates nothing.
3) If the above two guidelines do not provide conclusive information, try the following. For example purposes, suppose a file named "**xxx.eml**" is distributed with IMAGINE and that you want to modify it.

To find out whether "**xxx.eml**" is a stand-alone EML script, you need to look for the name, "**xxx.eml**", in the other IMAGINE EML scripts. If you find "**xxx.eml**" in another EML script, and you find that it is loaded from the other script via the load command, then xxx.eml is definitely a stand-alone EML script. If you have searched all of the IMAGINE EML scripts and do not find "**xxx.eml**" in any of them, then it is definitely an application-bound script.

Note: All EML Scripts distributed with IMAGINE are found in **<IMAGINE_HONE>\scripts** folder.

How to design a GUI

The code Snippet (Sec2_02) will generate an empty GUI framework; you may wonder that how to setup these geometry parameters?

Using Geometry to design a GUI is a simple matter of arithmetic, but it can be very confused and complex. There is however software, such as Open Office Draw, to help design GUIs. Here are the steps to design an EML GUI in Open Office Draw:

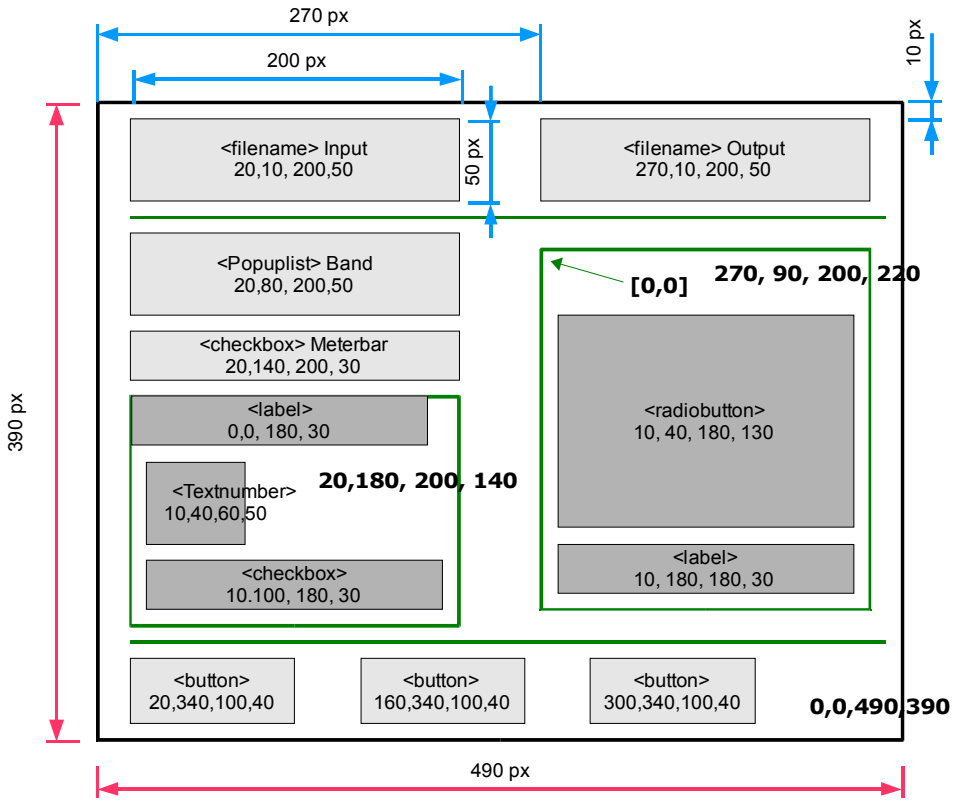
(1) Select Tools->Options->OpenOffice.org Draw->General, change unit of measurement to "point"
Note: there is no pixel unit, so select the point unit.

(2) Select View->Zoom->Zoom Factor, change the variable to **76**%
Note: changing the zoom factor to 76% will make point units look like pixel units.

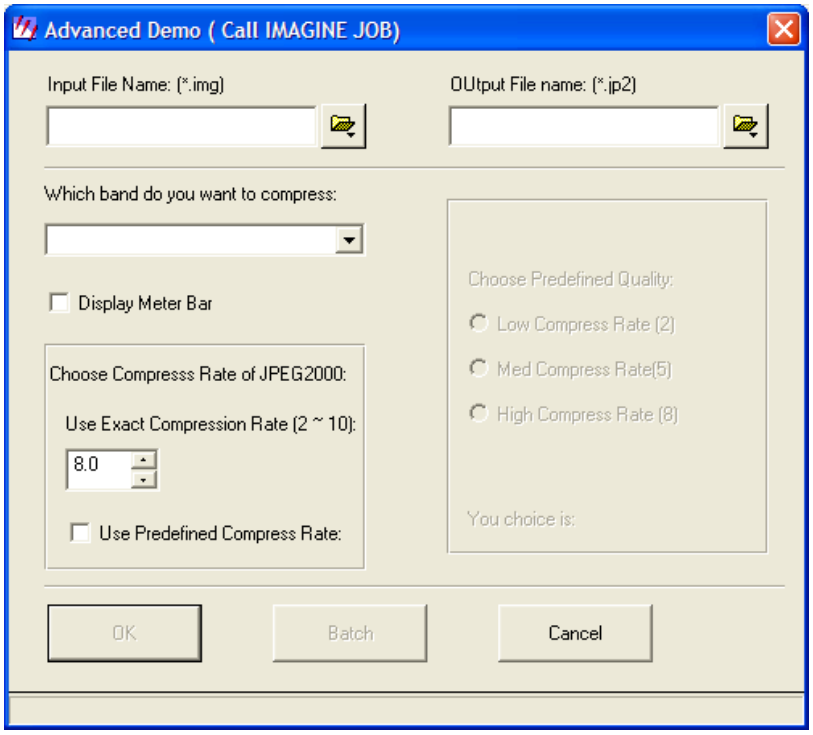
(3) Drag a polygon into the layout, you can use your mouse to change its size and location. For the best accuracy, RMB to open the options dialog box and choose the Position and Size option and specify the exact value for size and position.

(4) After resize and reposition, you may RMB Position and Size, enable Protect "Position".

The Open Office Draw output should look like the following figure

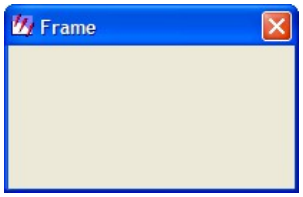
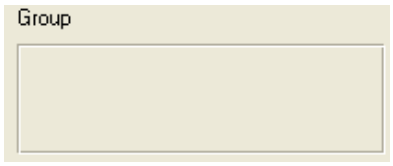
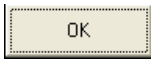
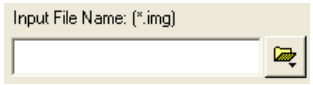
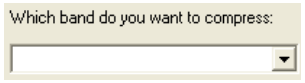


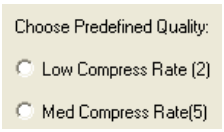
Once your script is parsed through IMAGIE EML library it should look like the following dialog box.



Naming Rule

Take note that each of the Frame Part variables have a similar prefix e.g. "**frm_**". It is a good programming habit to keep certain Naming Rules throughout your program. The following table shows an example of Naming Rules in EML, which are used in this training manual. You may however wish to use your own Naming Rule when you return to your office.

EML Component & Framepart	*Desired Variable Name*
EML Component	Use the same name as your EML script
Frame 	**frm_Name**
Group 	**grp_Name**
Button 	**btn_Name**
Filename 	**fln_Name**
EditText	**edt_Name**
Textnumber	**txt_Name**
CheckBox	**chk_Name**
Popuplist 	**pop_Name**
Label	**lab_Name**

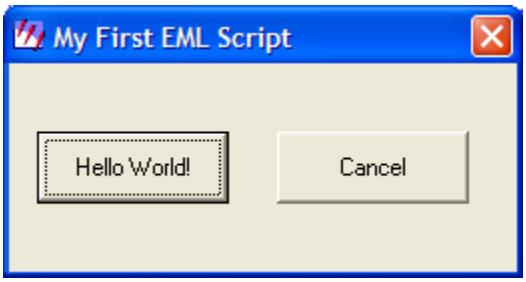
You choice is: 3	
Radiobutton 	**rad_Name**
Line 	**lin_Name**
Customized Procedure (action code)	**pro_Name()**
Customized Application Function (name of the application function, introduced later in this course)	**app_Name()**

Exercise 1: Your first EML Script

Exercise Objective:

This exercise will help you write your first eml script, and you will learn basic syntax and rules.

This example will display a dialog with two buttons, clicking on the "**Hello World**" button will bring you a message box. The dialog will look like the figure below:



Code Snippet (Sec2_01): "Hello World" EML Script

```
/*
** YOUR FIRST HELLO WORLD EML SCRIPT.
*/
component HelloWorld
{

      frame HelloWorldFrame; # FORWARD DECLARATION

      frame HelloWorldFrame
      {
            title "My First EML Script";
            geometry 50, 50, 250,100;    # GEOMETRY BASED ON SCREEN COORDINATE

            button OKb;            # FORWARD DECLARATION
            button cancelb;              # FORWARD DECLARATION

            button OKb
            {
                  title "Hello World!";
                  geometry 10,30,100,40;  # GEOMETRY BASED ON
                                          # COMPONENT INTERNAL COORDINATE
                  on mousedown
                  {
                        message("Hello World!\n Your first EML.");
                  }
            }

            button cancelb
            {
                  title "Cancel";
                  geometry 130, 30, 100, 40;
                  on mousedown
                  {
                        unload;
                  }
            }
      } # CLOSE OF FRAME


      on startup
      {
            display HelloWorldFrame;
      }

} # CLOSE OF COMPONNET
```

Code Explanation:

Note that the component is named "**Helloworld**" because the script name is "**Helloworld.eml**".

Also note that the frame, "**HelloWorldFrame**", is declared before it is actually defined. This is known as a "forward declaration". While forward declarations are not always required, it is good practice to use them

at all times. When you use forward declarations, you tell the EML interpreter that a particular frame or framepart exists. Without this information, the EML interpreter will fail when frames or frameparts attempt interact with each other. That is, without a forward declaration, an EML frame cannot interact with a subsequently defined frames or frameparts.

Note: *EML is not case sensitive. For example,* ***COMPONENT*** *and component are the same in EML.*

Comments

The example script contains several strings that start with "**/***" and end with "***/**" These strings are comments. As in SML, EML comments are useful for explaining what we intend to do. You must be very careful to close each comment you open in an EML script. You should also bear in mind that comments cannot enclose other comments. You may also use "**#**" to comment the single line

For example:

```
/* This is
valid */


# This is valid too


/* This is not
*/
valid */
```

In the third example above, EML will think that there is only a single comment which starts before the word "**This**" and ends after the word "**not**". It will attempt to interpret the string "**valid */**" as part of the EML script language and will report an error.

More about Frame

First note that the frame presented in the example contains a title attribute. It has the following syntax:

```
TITLE "<title string>";
```

While the script will function without this attribute, but you should consider the title attribute to be a required attribute. This attribute causes the frame title to appear in the border of the frame window when it is displayed. The title makes the purpose of the GUI clearer to the user.

Button framepart Features

As in the frame, a title attribute is used with the button framepart in this script. With buttons, you should consider the title attribute to be required. It provides the label for the button. Another mechanism for labeling button frameparts involves using the icon attribute. This attribute is used with an icon file name and has the following syntax:

```
ICON <iconfilename>;
```

However, even when an icon file is used to label a button, the title attribute should also be used. This way, if the icon file is not available, the title attribute provides a label that is meaningful to the user.

You may find icons used by IMAGINE in **<IMAGINE_HOME>\cons** folder, and they are *.ico and *.icon. The following statement will load fcopen.icon from <IMAGINE_HOME>\cons folder.

```
icon "fcopen.icon";
```

Reserved keywords

When naming frames and frameparts in EML scripts, it is important to avoid using EML reserved words. In the example script, note that the button has been named "**cancel**" instead of "**quit**". This EML script would fail if we attempted to name the button "**quit**" because "**quit**" is a reserved word in EML. One of the best ways to avoid this problem is to append a character or a string to any frame or framepart name. For example, for button frameparts, if you always add the letter "**btn**" or the string "**button**" to the part name, you will virtually always avoid inadvertent use of reserved words.

Geometry

The geometry attribute is one of the most important attributes in EML. It is important that you learn to use it and become comfortable with it. It is a key element in creating user interfaces that have the look and feel of standard IMAGINE interfaces. By providing interfaces with this consistent look and feel, you will make it easier for your users to learn and understand them.

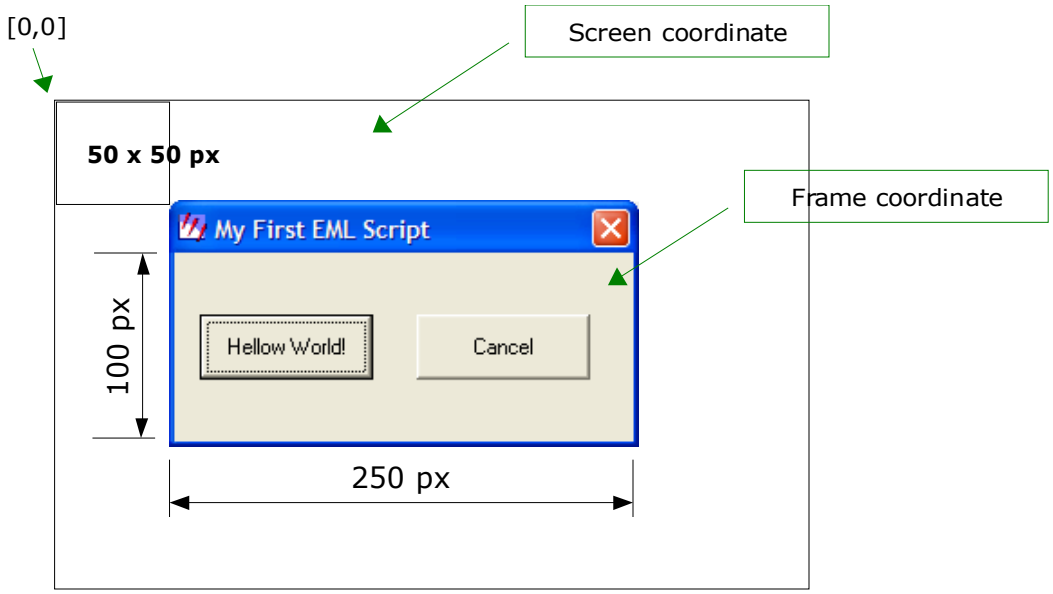
As you will notice when working with EML, most EML frameparts have default geometries. For example, by default, the size and shape of a button is determined by the title (or by the icon if an icon file is used to label the button). Similarly, you will also notice that the frameparts defined within a frame appear from left to right in the order they are defined.

The geometry attribute should always appear with the other attributes at the beginning of the frame or the framepart. The syntax of the geometry attribute is:

```
GEOMETRY <x>, <y>, <width>, <length>;
```

The first two parameters provide information about where the upper left corner of a framepart should be positioned within a frame. The second two parameters determine the size of the frame or framepart. It is your responsibility to make sure that the geometries for frameparts within a given frame do not overlap and that their coordinates represent valid locations within the frame. While this is a simple matter of arithmetic, it is important to be aware that you are responsible for defining appropriate geometries.

In the "**Helloworld.eml**", the geometry can be based on different coordinate system. Geometry for the frame is based on your screen coordinate, while the geometry for the framepart (i.e. button) is based on frame internal coordinate. The following figure shows the geometry of "**Helloworld.eml**".



The Load Command

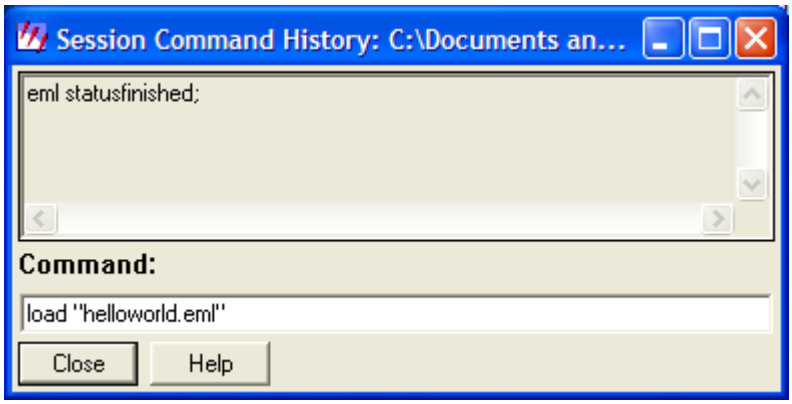
Once we have written a stand-alone EML script, we need load it in the IMAGINE session using the load command in order to see what it looks like. The **load** command can be used both in the commands dialog and in other EML scripts. The syntax of this command is:

```
LOAD "<EMLScriptName>.eml";
```

It instructs the IMAGINE session manager to load the component contained in the script, **"<EMLscriptname>.eml"**. Note that the script name itself must be enclosed in quotes due to the fact that it contains the character, "**.**".

Before you use the load command for the first time, use the preference editor to make sure that the "Log Message level" preference in the "User Interface & Session" category is set to "**verbose**". This will cause all syntax error information to appear in your session log, in addition to the error message windows that will appear on the screen. Thus, you can dismiss the error message windows from the display without losing the information they provide.

For example, here is how you load your "**helloworld.eml**" from command line (i.e., type **load "helloworld.eml**", and then press ENTER key).



Tips for Debugging EML Scripts

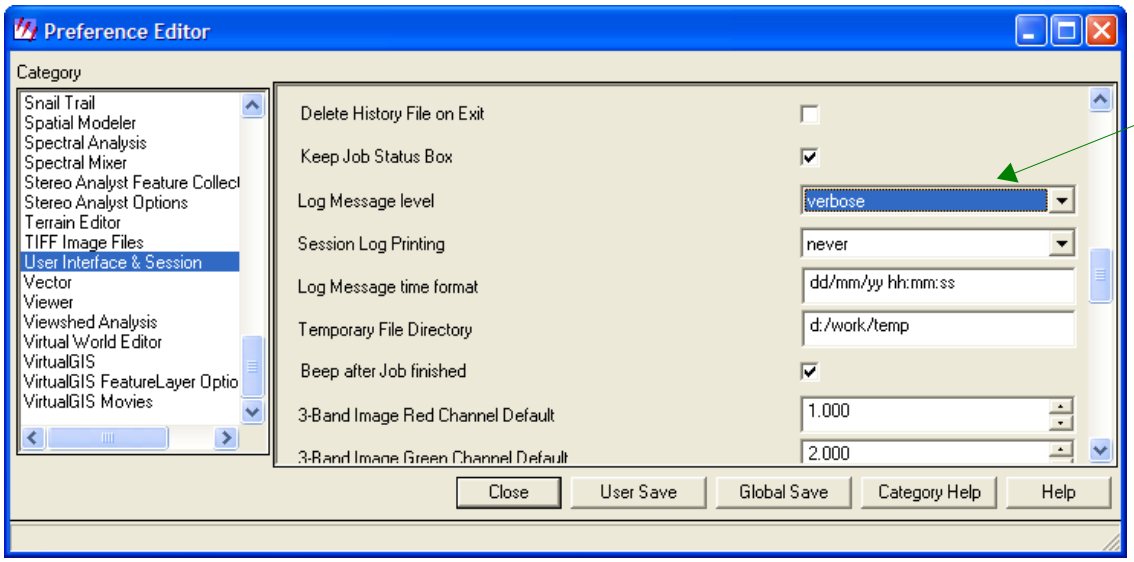
As with all programming languages, you will need to debug your EML scripts. Typographical errors are the most common cause of syntax errors in computer languages. These are the first errors you should check for when you have problems loading your EML scripts:

- Is therea missing semicolon "**;**" on the line preceding the line where the syntax error is reported?
- Is there a missing curly bracket ("**{**" or "**}**") on any of the lines preceding the line on which the syntax error is reported?
- Are there title strings (or other strings) that are missing closing quotes on any lines preceding the line on which the syntax error is reported?

See your Errors in Session Log

IMAGINE Session log is our good friend to debug EML scripts, session log will display the status, error, and information text generated by all the applications. All the messages in the session log are date/time stamped. The session log window can be reached from the main icon panel under the session pulldown menu.

The log message can be of two types in your preference: Verbose and Terse. For troubleshooting and debugging, however, verbose messages can prove to be more useful.



Class Notes:

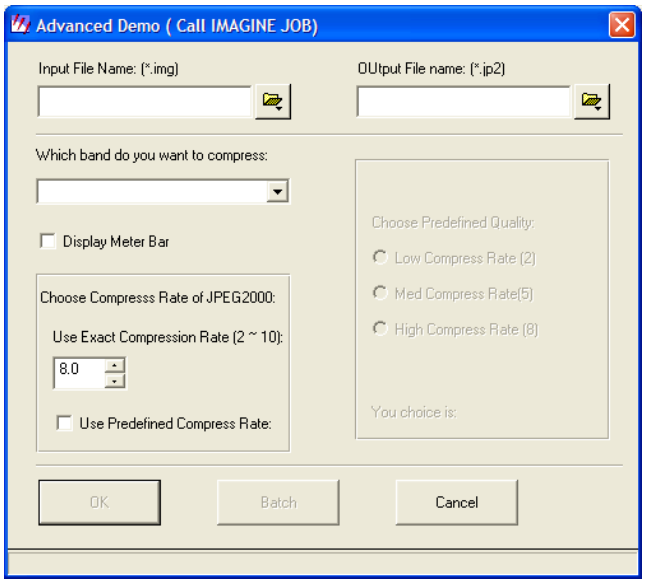
Exercise 2: An Advanced EML Framework

Exercise Objective:

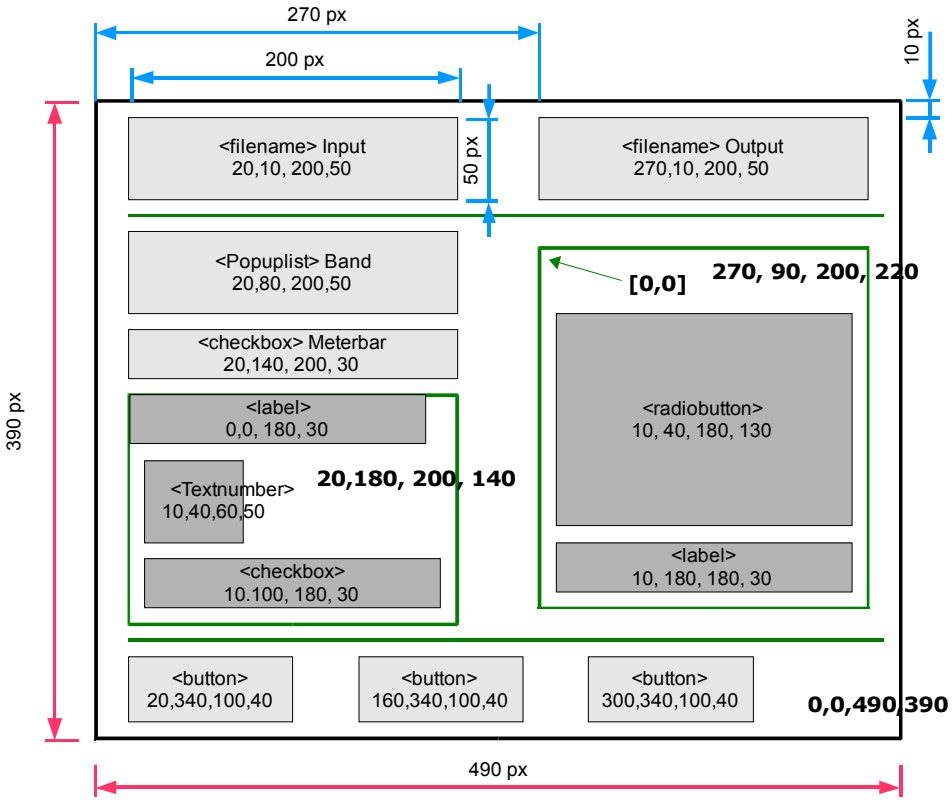
In this exercise you will create an EML framework, which only contains the GUI components and no action code. We will add action code in the next exercise.
Here we want to create a EML program which can compress img file to JPEG2000. The GUI interface may also allow users to select the compression rate. We also, will learn how to design the GUI, and learn the naming rules for EML scripts.

The code used in this exercise can be found on the course CD (Sec2_02.txt). This code is listed below.

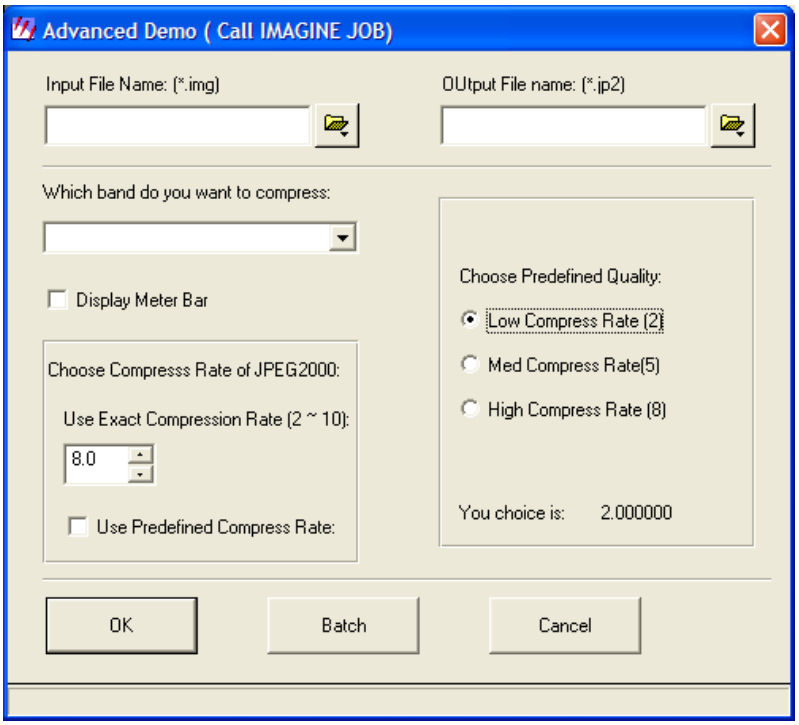
The code used in this exercise will generate an Advanced Demo GUI, e.g. shown below.



Design the GUI



Once your script is parsed through IMAGIE EML library it should look like the following dialog box.



Code Snippet (Sec2_02): Empty GUI Framework (no action code)

```
/*
******************************************************************************
**
**    AN ADVANCED EML SCRIPT
**    EXPORT IMG TO ECW WITH DIFFERENT COMPRESS OPTIONS:
**          1. BAND (EITHER GRAYSCALE OR MULTISPECTRAL)
**          2. COMPRESS RATE
**
******************************************************************************
*/

component Demo
{

      frame frm_Demo
      {
            title "Advanced Demo ( Call IMAGINE JOB)";
            geometry 50, 50,490,390;     # GEOMETRY BASED ON SCREEN COORDINATE
            statusbar;              # GEOMETRY DOES NOT INCLUDE STATUSBAR

/*
******************************************************************************
**
**    DECLARATION
**
******************************************************************************
*/
            /*
            ** FRAMEPART FORWARD DECLARATION
            */
            filename fln_Input;
            filename fln_Output;
            popuplist pop_Bands;
            checkbox chk_Meterbar;
            group grp_Rate;
                  textnumber txt_ExactRate;
                  checkbox PredefineRate;
            group grp_PredefineRate;
                  radiobutton rad_PredefineRate;
                  label lab_Status;
            button btn_OK;
            button btn_Batch;
            button btn_Cancel;

/*
******************************************************************************
**
**    INPUT / OUTPUT FILES
**
******************************************************************************
*/
            filename fln_Input
            {
                  geometry 20,10, 200, 50;
```

```
                        # GEOMETRY BASED ON FRAME INTERNAL COORDINATE
                title above left "Input File Name:";
                select getpref("eml" "default_data_path") + "/*.img";
                filetypedef "raster";
                shortform;
        }

        filename fln_Output
        {
                geometry 270, 10, 200, 50;
                title above left "OUtput File name:";
                newfile;
                select getpref("eml" "default_output_path") + "/*.ecw";
                filetypedef "raster";
                shortform;
        }
        line lin_1
        { geometry 20,70,460,1; layout horizontal;}

/*
*****************************************************************************
**
**    JPEG2000 COMPRESS OPTIONS
**
*****************************************************************************
*/
        popuplist pop_Bands
        {
                geometry 20, 80, 200, 50;
                title above left "Which band do you want to compress:";
        }
        checkbox chk_Meterbar
        {
                geometry 20, 140, 200, 30;
                title "Display Meter Bar";
        }
        group grp_Rate
        {
                Geometry 20, 180, 200, 140;
                label lab_Rate
                {
                        geometry 0,0, 180, 30;
                                # GEOMETRY BASED ON GROUP INTERNAL COORDINATE
                        title "Choose Compresss Rate of ECW:";
                }
                textnumber txt_ExactRate
                {
                        geometry 10, 40, 60, 50;
                        title above left "Use Exact Compression Rate (2 ~ 10):";
                        rangespec 2,10;
                        value 8;
                        format "2.1";
                        # 2 IS THE TOTAL NUMBER OF DIGIT,
                                # 1 IS THE NUMBER OF DECIMAL
                        delta 0.1;
                                # THE NUMBER OF INCREMENTED OR DECREMENTED
                                # WHEN "NUDGERS" ARE USED.
                }
                checkbox chk_PredefineRate
                {
                        geometry 10, 100, 180, 30;
```

```
                        title "Use Predefined Compress Rate:";
                        value 0;          # SETUP DEFAULT TO UNCHECKED.
                  }
            }
            group grp_PredefineRate
            {
                  geometry 270, 90, 200, 220;

                  radiobutton rad_PredefineRate
                  {
                        geometry 10, 40, 180, 130;
                        title "Choose Predefined Quality:";
                        layout Vertical;
                        options {2,5,8};
                        #value "8";#DOESN'T WORK, YOU DON'T NEED TO WORRY ABOUT THAT.
                                    #DEFAULT CHOICE IS ALWAYS 1st CHOICE.
                        titlelist {"Low Compress Rate (2)",
                                   "Med Compress Rate(5)",
                                   "High Compress Rate (8)"};
                  }
                  label lab_Status
                  {
                        geometry 10,180, 180, 30;
                        title "You choice is:";
                        value $rad_PredefineRate;
                  }
            }
            line lin_2
            { geometry 20,330,460,1; layout horizontal;}

/*
*****************************************************************************
**
**    BUTTONS
**
*****************************************************************************
*/
            button btn_OK
            {
                  geometry 20,340, 100,40;
                  title "OK";
                  info "Process ECW Compression.";
                              # WILL DISPLAY ON THE STATUS BAR
            }

            button btn_Batch
            {
                  title "Batch";
                  geometry 160, 340, 100, 40;
            }

            button btn_Cancel
            {
                  title "Cancel";
                  geometry 300, 340, 100, 40;
                  on mousedown
                  {
                        unload;
                  }
            }
      } # CLOSE OF FRAME
```

```
/*
*****************************************************************************
**
**    COMPONENT PROCEDURE
**
*****************************************************************************
*/
      on startup
      {
            display frm_Demo;
      }

} # CLOSE OF COMPONENT
```

Code Explanation:

The following paragraphs explain the keywords used in the above code (Code Snippet (Sec2_02)). The keywords used in this exercise are only a sub-set of the available keywords. For a complete language reference look at the EML menu found in the **<IMAGINE_HOME>\Help\Hardcopy**.

The FILENAME Framepart, its attributes, and framepart functions

The FILENAME framepart is the most frequently used framepart in EML. It acts as a bridge between the data and the EML program.

The FILENAME Framepart

The filename framepart possesses some unique and very useful features. This framepart not only presents a list of file names within a particular directory, it also permits the user to navigate through directories to find desired files. These capabilities are built into the framepart itself. To use these capabilities, you need only define a filename framepart in your EML script. The basic syntax is:

```
FILENAME <name>
{
    TITLE "<String describing input file type>";
}
```

A single frame can contain several filename frameparts. Each one must have a unique name within the frame. While the title attribute is not technically required, you should consider it mandatory because it explains the purpose of the framepart to the user.

The NEWFILE Attribute

It is important to understand the default behavior of the filename framepart in order to understand why an output filename framepart has a slightly different definition than an input filename framepart. By default, the filename framepart assumes that the file identified by the user already exists. Thus, if you type the name of a file which does not exist into an input filename framepart, you will get an error message. If your intention is to use the filename framepart to create a new file, this presents a problem.

Thus, in order to create a file via the filename framepart, the **newfile** attribute is required. When this attribute is used, IMAGINE recognizes that the file specified need not exist. This attribute provides an additional service if the file specified does exist already. It warns the user that there is already a file with the specified name and allows the user to decide whether or not to overwrite the existing file.

You may find example from the example code snippet Sec2_02:

```
FILENAME fln_Output
{
    GEOMETRY 270, 10, 200, 50;
    TITLE ABOVE LEFT "OUtput File name:";
    NEWFILE;
    ...
}
```

The SELECT Attribute for Input Files

The **select** attribute is only used with the filename framepart. It allows you to filter the list of files in a particular directory so that only the files of interest are visible. The format of the select attribute is:

```
SELECT "<Filter String>";
```

A common setting for the select attribute in IMAGINE is:

```
SELECT "*.img";
```

When the select filename attribute specifies "***.img**", the filename framepart displays only files ending in .img in the directories you navigate. This makes it much easier for the user to find and select the desired input files.
The **select** attribute can also be used to set the search directory.

The SELECT Attribute for Output Files

While the **select** filename attribute provides a very obvious benefit when it comes to selecting input files, it also provides valuable services for naming output files. Typically with output files, we need to type in the file name rather than selecting the file from the list that appears in the filename part. (Indeed, if we did select the output file from a filename part, IMAGINE would warn us that the file exists and would provide the option of removing the existing file.)

The first benefit of using the select filename attribute with output file names is that you can use it to set default output directories to directories where you have write permissions.

The second benefit is that it helps avoid inadvertently typing existing file names because these names appear in the interface. While IMAGINE will warn you about this situation when it occurs, it is always better to avoid it if you know you do not want to overwrite any existing files.

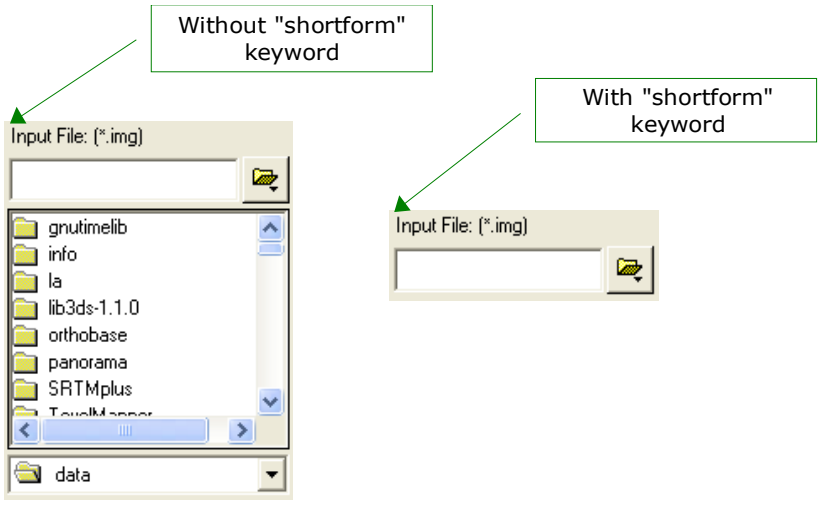
The third benefit is that all the user needs to type is the base name for the file and IMAGINE will automatically append the filter string if specified. For example, if you use "*.img" filter string with the select attribute, then if you type the word "out" in your output filename framepart, IMAGINE will automatically convert it to "out.img". You should always try to make the user's work easier when you create GUIs with EML scripts. The select filename attribute is often a very good way to do this.

The SHORTFORM Attribute

The **shortform** filename attribute simply gives the filename framepart a different appearance. By default, the filename framepart displays the list of files. When the **shortform** attribute is used, this list does not appear. Only the name of the selected file appears. Note that the user can still navigate the directory structure and select files via a visual interface. All the user needs to do is to click on the file icon that appears to the right of the text field for the file name.
The shortform attribute is especially useful in very complex interfaces. The more compact representation can often make the GUI clearer to the user. The **shortform** attribute should always appear with the other **filename** attributes at the top of the **filename** description. The syntax for this attribute is:

```
FILENAME fln_Output
{
    ...
    SHORTFORM;
    ...
}
```

The following figure demonstrate the difference between with and without the **shortform** keyword.



FILENAME functions

In addition to its directory navigation and file naming services (checking to see if input files exist, automatically appending file extensions, warning if output files already exist), the **filename** framepart possesses framepart functions. These functions provide information about the file entered via the filename framepart. These functions are accessed via the name of the **filename** framepart followed by "**.<functionname>**". So if the **filename** framepart was named infile, we would access the **filename** framepart functions as follows:

```
$fln_Input.<functionname>();
```

One very useful filename function in writing EML interfaces for SML scripts is the .datatype() function. This function assumes a raster input file and returns a string representing the pixel type such as "**U8**", "**U16**", "**F32**", etc. You can use these values to send appropriate arguments to SML scripts to set data types for input and output files.
You may find example in the following section.

The GETPREF() Command

Understand Preference Definitions before we get to GETPREF() Command

When you use the Preference Editor to modify preferences, you are actually modifying the settings of specific preference values. The initial values for these preferences are stored in Preference Definition Files ("***.pdf**" files) which are found in **<IMAGINE_HOME>\defaults**. It is important to be aware of the existence, location, and names of the .pdf files in order to use the EML **getpref()** function.

Each "***.pdf**" file in **<IMAGINE_HOME>\efaults** contains preferences for a particular preference category. The preference category most commonly modified by IMAGINE users is the "User Interface & Session" category. If you examine the "***.pdf**" files in <IMAGINE _HOME>\default you will see that the name of the file associated with this category is "**eml.pdf**". The basename of this file, eml, will be important when we use the **getpref()** function in EML.
The general syntax for a preference in a "**.pdf**" file is:

```
<preferencename>("<preferencetitle>"): <defaultvalue>
            "<bubblehelpinfo>"
            <preference attributes>
```

Let's look at an example to understand this better. Many IMAGINE programs use **<IMAGINE_HOME>\examples** as the default directory for finding input image files. The preference used to find this directory is default_datapath and is found in "**eml.pdf**". Here's the preference definition:

```
default_data_path("Default Data Directory"):
           "$IMAGINE_HOME/examples"
           "Default data path for images"
           maxlength 256;
```

First we see the preference name is default_data_path. The preference name is required when using the **getpref()** function. Next we see the preference title which appears to the left of the preference setting when the Preference Editor is displayed.

Next is the default value for the preference. This is the value of the preference before any user attempts to modify preference settings.

Next we see the string that will appear on the screen when bubble help is enabled.

Finally, we see the maxlength attribute. There are different types of preferences (e. g., strings, numbers) and each type has its own attributes. In this case, the maxlength attribute indicates that default_data_path cannot contain more than 256 characters. When you work with the **getpref()** function, you will only need to concern yourself with the name of the preference you wish to access and the name of the .pdf file which contains this preference.

You should be aware that when you change preference values via the Preference Editor, the changes are not written to the .pdf files but rather to one of two v8preference files. When you save changes at the user level, the new preference value is stored in a v9preference file found in the **".imagine910**" directory under your home directory. If you have the required write permissions, you can also save preferences at the global level. The v9preference file which stores these changes is found in the <IMAGINE _HOME>\defaults directory.

The GETPREF() Command

The **getpref()** function allows you to extract a preference value for use in an EML script. It has the following syntax:

```
GETPREF ( "<pdfbasename>", "<preferencename>" ) ;
```

If, for example, you wanted to extract the "Default Data Directory" preference from the "User Interface & Session" category, you could call the getpref() function as follows:

```
GETPREF ( "eml", "default_data_path" ) ;
```

In this case, eml is the base name of the file, eml.pdf, which stores the "User Interface & Session" category. The string, default_data_path, represents the name of the preference associated with "Default Data Directory".

When the **getpref()** function is called, it looks in three different places for the value of the specified preference. First, it looks to see if there is a v8preference file in your .imagine830 directory. If there is, it checks to see whether the preference you have specified appears in the file. If so, **getpref()** uses this value. Otherwise, it checks to see whether there is a v8preference file in the <IMAGINE_ HOME>\defaults directory. Again, if the file is found and the specified preference appears in it, **getpref()** will use this value. If **getpref()** does not find the preference setting in either of these two files, it uses the default value from the .pdf file.

One example of how the **getpref()** function can be used is to set paths with the select filename attribute. For example:

```
SELECT GETPREF ( "eml", "default_data_path" ) ;
```

would automatically position the filename selector in the defalult_data_path directory. This can be further enhanced by appending a filter string to the end of the path as follows:

```
SELECT GETPREF ( "eml", "default_data_path" ) + "/*.img";
```

Using the select filename attribute in this way not only automatically positions the filename framepart in the directory specified by default_data_path, but it will only display the files in that directory which end in "**.img**".

Note: *You may find detailed description about preference database from EML User Manual.*

The RADIOBUTTON Framepart

The radiobutton framepart is used to present a short list of options to a user. Actually we should call it readiogroup, because it consists of one or more entries each with a radio button displayed to the left of it. Typically, the radiobutton framepart should not be used to present more than four or five options. This framepart is similar to the buttons on a car radio. All options are visible but only one can be selected at any given time. It is because all options are always visible that this framepart should only be used for short lists of options. Otherwise, it can take up too much space in the interface. Also, when too many options are simultaneously visible, it can make the interface very confusing.
The basic syntax for the radiobutton framepart is:

```
RADIOBUTTON <optionlistname>
{
     TITLE "<optionlisttitle>";
     OPTIONS { "<opt1>", "<opt2>",..., "<optn>" };  # VALUE OF THE RADIOBUTTON
     VALUE "<defaultvalue>";
     TITLELIST {"Info1","Info2",...,"Infon"};  # DISPLAY ON THE GUI
}
```

You may also put numeric value on the options; it will act the same as the string.

```
RADIOBUTTON <optionlistname>
{
     TITLE "<optionlisttitle>";
     OPTIONS { <opt1>, <opt2>,...,<optn> };    # VALUE OF THE RADIOBUTTON
     VALUE <defaultvalue>;
     TITLELIST {"Info1","Info2",...,"Infon"};  # DISPLAY ON THE GUI
}
```

The **options** attribute provides the complete list of values associated with this framepart. Just as in the textnumber framepart, the **value** attribute can be used in the radiobutton framepart to set a default selection. Otherwise, the first value in the options list will be selected by default.
Another useful attribute is the **titlelist** attribute. You can use this attribute to provide descriptive names for the options in the options list. Finally, the layout attribute can be used to set the orientation of the buttons. By default, the buttons are displayed vertically. The layout attribute can be used to force the orientation to be either horizontal or vertical.
Here is an example of a radiobutton framepart as it appears in an EML script:

```
radiobutton rad_PredefineRate
```

```
{
     geometry 10, 40, 180, 130;
     title "Choose Predefined Quality:";
     layout Vertical;
     options {2,5,8};     # VALUE OF THE RADIOBUTTON
     value 8;             # SETUP DEFAULT CHOICE
     titlelist {"Low Compress Rate (2)",
                "Med Compress Rate(5)",
                "High Compress Rate (8)"};# DISPLAY ON THE GUI
}
```

Notice that the buttons are vertically aligned because of the layout attribute. Notice also that the strings in titlelist appear in the interface. If the **titlelist** attribute were not used here, then the values from the options list would appear as the button titles. Finally, notice that the third button is automatically selected because of the value attribute. If the **value** attribute were not used here, the first button would be selected by default.

The POPUPLIST Framepart

Like the radiobutton framepart, the popuplist framepart presents the user with a list of options. However, in this case, only one of the options is visible at a time until the user clicks on the framepart. This causes the entire list of options to appear. In contrast to the radiobutton framepart, the popuplist framepart is useful for presenting long lists of options.
The basic syntax for the **popuplist** framepart is:

```
POPUPLIST <name>
{
     TITLE "<optionlisttitle>";
     NAMES { "<optl>", "<opt2>",     "<optn>" };
     TITLELIST {"Info1","Info2",...,"Infon"};
     VALUE "<defaultvalue>";
}
```

The **names** attribute serves the same purpose as the options attribute in the radiobutton framepart. By default, the names list provides the titles for the popuplist. However, just as with the radiobutton framepart, the **titlelist** attribute can be used in the popuplist framepart to present more descriptive titles for the options provided in the names attribute list.
And, as with the textnumber and radiobutton frameparts, the **value** attribute can be used to set the default value for the popuplist.
In our example, the content of **popuplist** will be automatically setup by input filename. You will learn that in the following section.

The CHECKBOX Framepart

The **checkbox** provides a toggle mechanism for on/off, yes/no, true/false types of response. The basic syntax for the popuplist framepart is:

```
CHECKBOX <name>
{
     TITLE "<checkboxtitle>";
     VALUE 1;   # SETUP DEFAULT TO CHECKED (1), UNCHECKED (0)
          # NOTE $CHECKBOX WILL ALWAYS BE NUMBER 0/1, NOT STRING
}
```

The TEXTNUMBER Framepart

The **textnumber** framepart provides an interface that allows users to conveniently set numeric values. The basic syntax of a textnumber framepart is:

```
TEXTNUMBER <name>
{
     TITLE "<numbertitle>";
     MIN <minvalue>;
     MAX <maxvalue>;
     RANGESPEC <minvalue>, <maxvalue>; # CAN REPLACE min, max
     VALUE <defaultvalue>;
     DELTA <Incremented or decremented nudgers>;
}
```

The **min** and **max** attributes are used to set the minimum and maximum values that the user is allowed to enter. This can help users avoid making mistakes because the textnumber interface will prevent them from making inappropriate choices. An additional attribute that can be used with the textnumber framepart is the **value** attribute. This attribute sets a default value for the textnumber part. If the value attribute is not used, the default value is the minimum value set by the min attribute.
Let's look at an example. This is textnumber framepart description from an EML script:

```
textnumber txt_ExactRate
{
     geometry 10, 40, 60, 50;
     title above left "Use Exact Compression Rate (2 ~ 10):";
     rangespec 2,10;
     value 8;
     format "2.1";   # 2 IS THE TOTAL NUMBER OF DIGIT,
                          # 1 IS THE NUMBER OF DECIMAL
     delta 0.1; # THE NUMBER OF INCREMENTED OR DECREMENTED
                     # WHEN "NUDGERS" ARE USED.
}
```

Note that because the **value** attribute has been set to 8, the number 8 automatically appears when the frame is displayed. If we had not used the value attribute, the number 1 would automatically appear.

Class Notes:

Exercise 3: Initialize Popuplist and Output Filename

Exercise Objective:

During this exercise you will add action code into the GUI framework. You will populate the Band list (**Popuplist**) and output (**Filename**) when you select your input image.

During the last exercise you learn how to design a GUI. The next step is to fill in the framework with your business logic. In this exercise you will learn the basic EML flow control statements and other useful functions.
In the code, below, you will learn how to automatically supply the output file name when you select the input file. You will also learn how to populate the file layer names into the popuplist framepart.

Here is what you should do:

Code Snippet (Sec2_03)

```
filename fln_Input
{
      ...

      on filenamechoosen           # EVENT HANDLER
      {
            /*
            ** SETUP POPUPLIST FOR LAYER NAME
            */
            variable namelist;     # VARIABLES CAN ONLY BE DEFINED IN EVENT HANDLER.
            variable titlist;
            variable i;
            set namelist      = {"0"};
            set titlist       = {"All Layers"};
            set i             = 1;
            while ( $i <= $fln_Input.nbands() )
            {
                  set namelist = {$namelist, $i };
                  set i = $i +1;
            }
            set titlist = {$titlist, $fln_Input.RasterLayerList() };
                        # SETUP LIST
            $pop_Bands.SetNameAndTitleList($namelist ,$titlist );
                        # $pop_Bands IS A STRING, EVEN THE NAME IS NUMERIC

            /*
            ** SETUP OUTPUT FILEANME
            */
            echo getpref("eml" "default_output_path");
            set fln_Output = getpref("eml" "default_output_path")
                                    + "/"+ froot($fln_Input) + ".ecw";
            send filenamechoosen to fln_Output;
      }

      ...
}
```

Code Explanation:

EML Message and Message Handler

The FILENAMECHOOSEN Message and its Handler

Unlike the **startup** message, which is strictly associated with loading an EML script, and the framedisplay message, which is strictly associated with displaying a frame, the **Filenamechoosen** message is associated with a variety of frameparts. Among these is the filename framepart.

Whenever a file name is selected or typed in to the filename framepart (and press enter), the **Filenamechoosen** message is sent. If you wish to trigger particular actions whenever a file name is selected, you can define an on **Filenamechoosen** message handler within the filename framepart. As with the **mousedown** message handler discussed above, the on **Filenamechoosen** message handler should be defined at the end of the framepart that uses it. For example, the basic syntax for a filename framepart that includes an on **Filenamechoosen** message handler would be:

```
filename <name>
{
    title "<titlename>";
    on filenamechoosen # Message Handler
    {
         (actions to take when input message is sent)
    }
}
```

A typical use for the on **Filenamechoosen** message handler in a filename framepart is to enable another framepart which requires the file name. We will see an example of this when we look at the enable command.

The FRAMEDISPLAY Message and its Handler

Whenever a frame is displayed from an EML script, a **framedisplay** message is sent. Just as the on **startup** message handler (see above) is used to define what should happen when an EML script is loaded, the on **framedisplay** message handler can be used to define what should happen when a frame is displayed.

The on **framedisplay** message handler must be defined within the frame that uses it but must be outside any of the frameparts that exist in the frame. By convention, the on **framedisplay** message handler is defined at the end of the frame. The basic syntax for a frame that contains an on **framedisplay** message handler is:

```
frame <name>
{
    title "<title>";

    ...framepart definitions...

    on framedisplay
    {
         (actions to take when frame is displayed)
    }
}
```

For an example of the on framedisplay message handler, refer to the discussion of the **disable** command below.

The VALUECHANGED Message and its Handler

The **valuechanged** message is similar to the input message except that a **valuechanged** message is issued for each change made to a framepart including changes involving individual keystrokes. While applicable to several frameparts, the on valuechanged message handler is typically applied to the textnumber and meternumber frameparts.

The basic syntax for the on **valuechanged** message handler is the same as for other message handlers:

```
on valuechanged
{
    (actions to take when valuechanged message is sent)
}
```

Variable and Array List, and the Set Command

The VARIABLE and the Set Command

A variable may be either local (**variable**) or global (**global**).
Local variables defined at the component level are available to all procedures, menus and frames defined in the component.
Global variables are available across applications. Any variable used in an EML script should be declared as either global or variable.

The syntax for defining a variable is:

```
variable name ;
global name ;
```

In either case a variable is a named container which may hold one or more values which can be numbers, characters, or strings of characters.

The value of a variable may be established with the set command. The **$** operator is used to get the value of a variable.
The syntax for retrieving the value of a variable is:

```
$name
```

The Array List and set Command

The **{ }** (list construction) operator creates a single item which contains multiple values. This is like an array in other programming languages and may be indexed via the **[ ]** (index) operator. The individual expressions between the braces may be space or comma separated.

Note: *The Index of List always starts from 1, not 0.*

Here is an example on how to use list.

```
variable listname;
set listname = {1, 2, 3};     # INIT LIST
set listname = {$listname, 4}; # APPEND LIST
```

Flow Control Statement

The IF Statement

The **If()** flow control (or conditional) statement is common to many computer languages. Often in EML, we use commands and functions directly. But sometimes we will want to check for specific conditions to determine whether it is appropriate to execute certain commands or conditions. Here is a conceptual example that illustrates the general purpose of the **If()** statement:
If the user has provided all of the required inputs, then execute the model. The syntax of the **If()** statement in EML requires that the condition evaluated appears in parentheses. When the condition is true, one or more commands or functions can be executed as a result. In order to associate more than one action with a condition, the actions must be enclosed in curly brackets (**{ }**). So the basic syntax for an **If()** statement in EML is:

```
if ( <condition> )
{
    (actions)
}
else if ( <condition> )
{
    (actions)
}
else
{
    (actions)
}
```

One application for the if() statement is to enable a framepart that has been disabled. The if() statement can be used to verify that the user has provided the inputs required to justify enabling another framepart. We will see an example of this in our discussion of the enable command below.
Typical conditions evaluated by the **If()** statement include checks for:

Operators	
Equality (is equal to)	**==**
Inequality (does not equal)	**!=**
Greater than	**>**
Greater than or equal to	**>=**
Less than	**<**
Less than or equal to	**<=**

The WHILE Statement

The **while()** statement allows you to repeatedly execute a set of functions or commands. This sort of repetitive processing is generally referred to as a "loop". The **while()** statement is only one example of a looping mechanism in EML. Other examples include the **foreach()** statement and the **loop()** statement. See the Appendix C for more information about these.
In EML, loops are typically used to run the same model (or other JOB program) several times. The basic syntax of a while statement is:

```
while ( <condition is true> )
{
    <action1>;
    <action2>;
}
```

Notice that like the **If()** statement, the while() statement evaluates a condition. However, the **if()** statement evaluates the condition only once whereas the **while()** statement evaluates the condition repeatedly until it is no longer true.
Let's look at an example. This is **while()** example from an EML script:

```
while ( $i <= $fln_Input.nbands() )
{
    set namelist = {$namelist, fmt($i,"?") };
    set i = $i +1;
}
```

In this case **While()** statement will setup an array list, and fill in with the band number. If the band number is 3, in the end the array list will be {“0”, “1”, “2”, “3”}.

The FPATH(), FROOT(), FEXT(), and FMT() Command

When you enter a filename via the filename framepart, the full path and name of the file is contained in the filename variable. That is, although the user interface appears to show only the name of the file, the filename framepart contains the full path information as well.
The **fpath()** function can be used to extract the directory path from a filename framepart or from any other string containing a file path.
The **froot()** function extracts the root name of a file from its full path.
The **fext()** function extracts the file extension from a file name.
Here is an example of how to use these command together:

```
filename fln_Input
{

     on filenamechoosen              # EVENT HANDLER
     {
          echo "filename=" $fln_Input;
           echo "Fpath()=" Fpath($fln_Input);
          echo "Froot()=" FROOT($fln_Input);
          echo "Fname()=" FNAME($fln_Input);
          echo "Fext()=" FEXT($fln_Input);
     }
}
```

In the Session Log, you will see:

```
13/08/07 15:39:10 SessionMgr(4936): filename =  d:/work/data/2-2.img
13/08/07 15:39:10 SessionMgr(4936): Fpath()= d:/work/data/
13/08/07 15:39:10 SessionMgr(4936): Froot()= 2-2
13/08/07 15:39:10 SessionMgr(4936): Fname()= 2-2.img
13/08/07 15:39:10 SessionMgr(4936): Fext()= img
```

The fmt function is used to format numbers. It converts the number argument (which must be a number) into a string using the format control string.
The syntax of this function is:

```
fmt (<numericvalue>, "<formatstring>");
```

The numeric value can be represented as a number (e.g., 2) or as a variable (e.g., **$numval**). There are a variety of format control strings including strings for representing dates and times. However, the control strings you will typically want to user are those representing digits in decimal numbers. The characters used in these format strings are, "**0**", "**#**" and "**?**".

You can include decimal points in format control strings to indicate how many digits are desired before or after the decimal point. You can also include commas to indicate that thousands digits should be comma delimited. While the "**#**" character will format the number with the minimum digits required to represent it, the "**0**" and "**?**" characters provide space holding features. When "**0**" is used in these strings, leading and trailing zeros will appear in unoccupied spaces in the formatted number string.
Similarly, when "**?**" is used, leading and trailing blank spaces will appear in these locations. Note that when integer formats are defined for floating point numbers, the **fmt()** function will round the value to the nearest integer. Here are some examples of formatted numbers produced by using these format control characters.

Consider the following assignments:

```
variable num;
set num = fmt (2.4, "##.##");
set num = fmt (2.4, "00.00");
set num = fmt (2.4, "??.??");
```

The variable, num, would take on the following values respectively:

2.4
02.40
2.4

The SEND Command

The **send** command delivers a message to a destination. Messages are typically generated and delivered by the core of the EML system in response to user input events. However, messages may be explicitly generated and delivered using the send command.

The syntax of send command is:

```
SEND <message> to <Frame or framepart>
```

Here is an example of a **Send** command as it appears in an EML script:

```
filename fln_Input
{
     ...
     on filenamechoosen              # EVENT HANDLER
     {
          ...
          send filenamechoosen to fln_Output;
          ...
     }
}
```

fln_Input will send a **filenamechoosen** message to **fln_ouput**, the Message handler from **fln_output** will response to this message.

Class Notes:

Exercise 4: Output Debug Information

Exercise Objective:

There is no built-in debug tool for EML, so printing the debug information to the IMAGINE session log is very helpful. In this exercise, you will learn how to print debug information.

It is very useful to output debug information when you are debugging EML script, you can add the following code block into the framework you used during exercise 2 and 3.

Code Snippet (Sec2_04): Output Debug Information

```
filename fln_Input
{     ...
      on filenamechoosen                # EVENT HANDLER
      {     /*
            ** OUTPUT DEBUG INFO
            */
            echo "The File Type (Truecolor, greycolor, pseudocolor, annotation,
                  coverage) is :"
                 + $fln_Input.FileType();
            echo "The Data Type (U8, U16, S8, S16..) is :"
                 + $fln_Input.Datatype();
            echo "Pixel size [height, width] unit is :"
                 + "[" + $fln_Input.pixelheight +","
                 + $fln_Input.pixelwidth + "] "
                 + $fln_Input.units();
      }
      ...
}



popuplist pop_Bands
{     ...
      on valuechanged
      {     /*
            ** OUTPUT DEBUG INFO
            */
            echo "$pop_bands=" $pop_bands;
      }
      ...
}
```

```
group grp_Rate
{     ...
      textnumber txt_ExactRate
      {     ...
            on valuechanged
            {     /*
                  ** OUTPUT DEBUG INFO
                  */
                  echo "Current Rate is" + $txt_ExactRate;
            }
            ...
      }
      ...
}
```

Code Explanation:

The ECHO Command

The **Echo** command prints its arguments to the session log. There may be any number of arguments of either string or numeric type. A newline is printed after all of the arguments. This command is typically used to debug EML scripts.
The **echo** command has the following syntax:

```
echo <arg1>  <arg2>  ...  <argn>;
echo <arg1>, <arg2> ,..., <argn>;
echo <arg1> + <arg2> + ... + <argn>;
```

Class Notes:

Exercise 5: Disable & Enable Framepart

Exercise Objective:

This exercise instructs you on how to disable and enable the frameparts when necessary.

You can add the following code block into the framework we used in exercise 4.

Code Snippet (Sec2_05): Disable / Enable Framepart

```
group grp_Rate
{
	checkbox chk_PredefineRate
	{
		...
		on valuechanged
		{
			if ($chk_PredefineRate == 1)
			{
				enable grp_PredefineRate;
				disable txt_ExactRate;
			}
			else
			{
				disable grp_PredefineRate;
				enable txt_ExactRate;
			}
		}
	}
	...
}

filename fln_Output
{
	...
	on  filenamechoosen
	{
		if ($fln_Input != "" && $fln_Output!= "")
		{
			enable btn_OK;
			enable btn_Batch;
```

```
            }
      }
      ...
}

...
on framedisplay
{
      disable grp_PredefineRate;
      disable btn_OK;
      disable btn_Batch;
}
```

Code Explanation:

The DISABLE Commands

In the user interfaces you create with the EML script language you will often find it is wise to disable different frameparts that appear in a frame. This is often done to help the user avoid making mistakes. For example, if the EML script you create is intended to apply a spatial model to an input file and create an output file, the model will fail if either the input file or the output file has not been specified. If a button is used to run the model, this button can be disabled until the user provides both file names.
The disable command can be used to disable any framepart. The disable command has the following syntax:

```
disable <framepartname>;
```

The **disable** command is commonly used in the body of an on framedisplay message handler. In the example described above, the disable command could be used to disable the button that runs the model. If the name of the button framepart was okbutton, the on framedisplay message handler for this frame would look like this:

```
on framedisplay
{
      disable grp_PredefineRate;
      disable btn_OK;
      disable btn_Batch;
}
```

It is a good idea to use the **disable** command to help the user avoid making mistakes. However, if you elect to use it, you must remember to include the enable command (see below) so that the user can execute models and commands once the required inputs and outputs have been specified.

The ENABLE Commands

The **enable** command is used to enable previously disabled frameparts. As mentioned in our discussion of the disable command, you will often want to disable certain frameparts to help users avoid making mistakes. For example, if you create an EML user interface to run an SML script that requires command line parameters, you can disable the button that allows the user to run the SML script until all of the required command line arguments have been entered via the EML GUI. Once they are entered, you can use the enable command to enable the button and run the model.

When you enable a previously disabled framepart, you will usually need to check to see that one or more conditions have been satisfied. The **if()** statement is typically used for this purpose. You will also need to check these conditions at the appropriate times. This is often done in message handlers such as the on input message handler.

Let's look at an example of how this might work. Suppose you want to use a button called **btn_OK** to run an SML script that requires one command line argument representing a file name. Upon displaying the frame that allows the user to provide the input filename, you would disable the **btn_OK**. Suppose the name of the filename part for the output file is **fln_Output**. You could use an on **Filenamechoosen** message handler and a conditional statement (see information about flow control in EML below) to determine when **btn_OK** should be enabled. Here's the filename framepart we could use to do this:

```
filename fln_Output
{
     on  filenamechoosen
     {
          if ($fln_Input != "" && $fln_Output!= "")
          {
               enable btn_OK;
               enable btn_Batch;
          }
     }
}
```

Note that before enabling the btn_OK, we make sure that the user has provided a valid input file name. The **If()** statement literally means, "if the string for input and output filename are not an empty string, then enable the **btn_OK**." The symbol "**!=**" in EML means "does not equal". The empty quotes, **“”**, represent a string that has no characters. This way, we avoid enabling the **btn_OK** if the user inadvertently enters the filename framepart without selecting a file.

Class Notes:

Exercise 6: Call IMAGINE Application Command

Exercise Objective:

In order to fully utilize the powerful IMAGINE commands, we can call IMAGINE application commands from the EML script. This exercise will show you useful techniques and related EML commands.

Note: If your program is no working please let the instructor know. You are about to start real data processing i.e. you will be using the command **exportecw** , an IMAGINE application command, to convert an img file to ECW.

To convert an .img to ECW you need to add the following code block to the framework used in exercise 5.

Code Snippet (Sec2_06): Call IMAGINE Application Command (exportecw)

```
/*
*****************************************************************************
**
**    BUTTONS
**
*****************************************************************************
*/
      button btn_OK
      {
            geometry 20,340, 100,40;
            title "OK";
            info "Process ECW Compression.";  # WILL DISPLAY ON THE STATUS BAR
            on mousedown
            {
                  pro_ExportECW();
            }
      }

      button btn_Batch
      {
            title "Batch";
            geometry 160, 340, 100, 40;
            on mousedown
            {
                  batchjobname froot($fln_Output);
                  startbatchsingle;
                  pro_ExportECW();
            }
      }

      button btn_Cancel
      {
            title "Cancel";
            geometry 300, 340, 100, 40;
            on mousedown
            {
                  unload;
            }
      }
/*
*****************************************************************************
**
**    FRAME PROCEDURE
**
*****************************************************************************
*/
      on pro_ExportJPEG
      {
            /*
            ** CALL IMAGINE JOB
            */
            if ($pop_Bands == "0") # PROCESS ALL BANDS
            {
                  job exportecw
                        -inputfilename    $fln_Input
```

```
                -outputfilename $fln_Output
                -compratio  $txt_ExactRate
                -photointerp Multispectral;

        }
        else  # PROCESS INDIVIDUAL BAND
        {
                variable band;
                set band = $pop_bands.GetListIndex();
                           # INDEX START FRMO 1, BAND START FROM 1.

                job exportecw
                        -inputfilename    $fln_Input
                        -outputfilename $fln_Output
                        -bands  $band
                        -compratio  $txt_ExactRate
                        -photointerp Grsyscale;
        }
}
```

Code Explanation:

Buttons for Executing Commands

Buttons here will look like the button described above for unloading an EML script. However, in this case, the mousedown message handler (on mousedown) will be used to run an IMAGINE Application Command. The command, “Exportgeojp2”, used here will compress your input image to JPEG2000 format, and you may able to change the compress rate and band.

The JOB Command

The **job** command is used only with IMAGINE JOB programs. These programs require initial input information from the user but do not interact with the user while they run. In general, they are data processing programs. Examples of IMAGINE JOB program are the IMAGINE Import and Export programs. The job command tells the IMAGINE session manager that the program is an IMAGINE JOB program. The session manager displays the progress meter as a result.
You may find all IMAGINE Application job Command under **<IMAGINE_HOME>\bin\Win32Release** folder, and you may find documentation from IMAGINE online help (Appendix->IMAGINE Application Command)

The SYNCJOB Command

The **syncjob** command is very similar to the job command. Like the **job** command, it is used to execute IMAGINE JOB programs. And, as the job command, it displays the progress meter. However, the syncjob command is different from the **job** command in some very important ways. Each time you execute the **job** command in an EML script, the job program specified is started immediately. So if you issued ten job commands in a row in an EML script, all ten programs would run simultaneously. This can cause a variety of problems. Suppose we have the following series

of job commands in an EML script and that each job program run reads an input image and creates an output image:

```
/* Don't do this */
job <prog1>;
job <prog2>;
job <prog3>;
```

Now suppose that the program, **<prog2>**, uses the output image from **<progl>** as its input image. In this case we will have a serious problem. This is because EML will start running the program, **<prog2>,** before **<progl>** has created an output image. The **syncjob** command prevents this problem.

When the **syncjob** command is used to run a job program from EML, it tells the EML interpreter to wait until the job program is finished running before it attempts to execute the next instruction in the EML script. So if **syncjob** were used instead of the job command in the above example, the output image from **<progl>** would be available by the time **<prog2>** was launched.

```
/* It is better to do this */
syncjob <prog1>;
syncjob <prog2>;
syncjob <prog3>;
```

Another important problem solved by the **syncjob** command is a problem that can arise when executing loops in EML (See the discussion of the **while()** statement). If you have a loop that launches the same job program hundreds of times, you can experience serious problems if you use the **job** command instead of the **syncjob** command. This is because EML will attempt to execute each **job** command statement simultaneously. If too many processes are started at the same time, your system will become so bogged down that none of the processes can progress at a reasonable rate. By using the syncjob command, you assure that only one process is run at a time.

The STARTBATCHSINGLE Command

The only programs that can be batched in IMAGINE are job programs such as the modeler program. There are two things you must do in order to batch a process from an EML script. First, you must issue the **startbatchsingle** command. The syntax for this command is simply:

```
STARTBATCHSINGLE;
```

Next, you must call the JOB program with job command. (E. g., **job modeler**). The **Startbatchsingle** command tells the EML interpreter to find the next job command and place it in a batch process. The standard batch dialog then appears allowing the user to set the date and time of execution.

The STARTBATCH/STOPBATCH Command

The **startbatch** and **stopbatch** commands work together to allow you to run several job programs in a single batch process. Whereas the startbatchsingle command simply loads the next job

command into a batch process, the startbatch command indicates that each subsequent job command should be loaded into a batch process until the stopbatch command is issued.

The following is an example of a batch button that loads several job commands into a single batch process:

```
button batchbutton
{
     title "Batch";
     on mousedown
     {
          set classnum = 1;
          startbatch;
          while ( $classnum <= 3 )
          {
               set outfile = fpath ( $outfilefolder )
                                  + froot ($infile )
                                   + " class" + fmt ( $classnum, "0" )
                                   + "." + fext ( $infile );
               job Jobname $infile $outfile $classnum;
               set classnum = $classnum + 1;
          }
          stopbatch;
          unload;
     }
}
```

Class Notes:

Challenge 1: Open Viewer from EML

Exercise Objective:

This exercise will instruct you to open the IMAGINE Viewer from your EML script.

It is nice to be able to view the input and output images after you finish the processing. Try the following code, see what happens?

Code Snippet (Sec2_07): Open Viewer

```
...
/* OPEN IMG IN VIEWER (COLOR) */
viewer create at 0 128 size 600 600;
viewer truecolor quote($fln_Name) rgb 1 2 3 transbackground 0;

/* OPEN IMG IN VIEWER (GREYSCALE)*/
viewer create at 0 128 size 600 600;
viewer greyscale quote($fln_Name) band 1 transbackground 0;
...
```

Code Explanation:

The VIEWER Command

There are three basic commands for displaying an image in the IMAGINE Viewer. Before using these commands from an EML script, you must make sure that a Viewer window is already open on the display. Otherwise, the commands will fail. The basic syntax for displaying a single layer of an image in gray scale is:

```
viewer greyscale quote ( <imagename> ) band <bandnum>;
```

For EML, the image layers are numbered from 0 to (number of layers -1). So the value of <bandnum> for a single-layer image will always be 0.

To display the same image in pseudocolor, the basic syntax is:

```
viewer pseudocolor quote ( <imagename> ) band <bandnum>;
```

This command is typically used for thematic images. Finally, if you wish to display a multilayer image in RGB, the display command has the following basic syntax:

```
viewer truecolor quote ( <imagename> ) rgb <r> <g> <b>;
```

In this case, <r>, <g>, and <b> should be the numbers of the layers you wish to load as the red, green and blue bands on the display. Keep in mind that the first layer is always 0. There are optional arguments for all three of these display commands. Refer to Appendix of IMAGINE online help for information about the optional arguments and for information about other Viewer commands.

Viewer command is not a JOB, because it is not supposed to process any data. You can not put **job** / **syncjob** before **viewer** command.

```
/* DON'T DO THIS */
job viewer truecolor quote ( <imagename> ) rgb <r> <g> <b>;
```

Class Notes:

Challenge 2: Add Toolbox Dialog & Menu

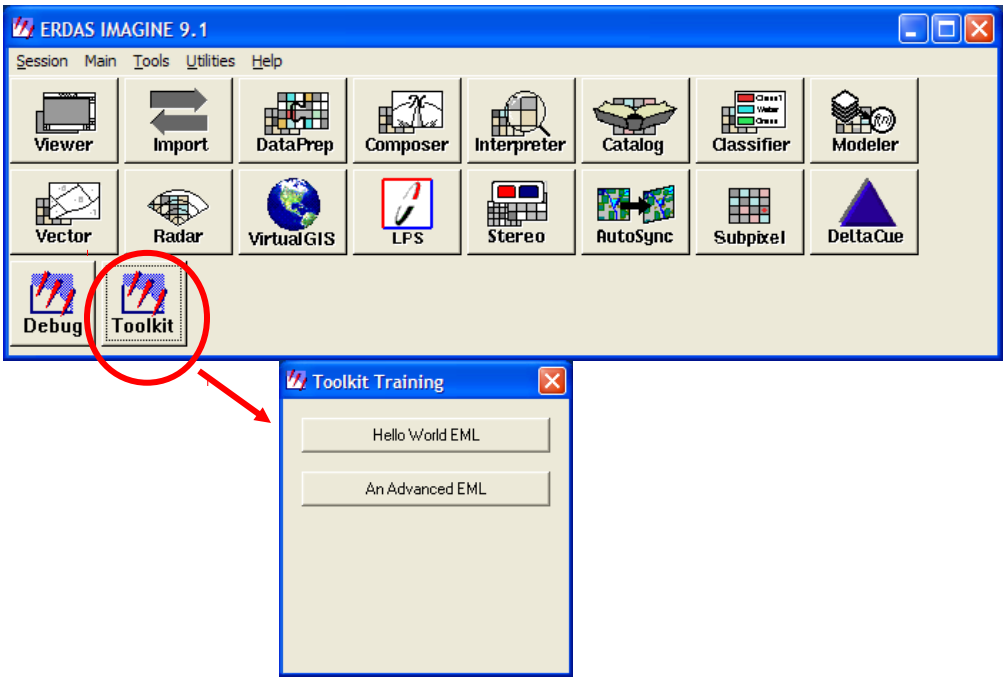
Exercise Objective:

This challenge will instruct you on how to add your own Toolbox dialog and Menu to IMAGINE.

Making a toolbox

You may make a toolbox that looks just like other IMAGINE toolboxes; here is how to do it.:

On the toolbar, shown below, click the Toolkit Icon, it will open the toolbox dialog.



Code Snippet (Sec2_08): Associate Toolbox dialog with Icon

```
/*
*****************************************************************************
**
**    AN TOOLBOX GUI FOR TOOLKIT ICON
**
*****************************************************************************
*/

component Toolbox
{

      frame frm_Toolbox
      {
            geometry 0,0,210,200;        # GEOMETRY WILL START FROM ICON (SMART)
            title "Toolkit Training";

            button btn_1
            {
                  geometry 10,10, 190, 30;
                  title "Hello World EML";
                  on mousedown
                  {
                        load "helloworld.eml";
                  }
            }
            button btn_2
            {
                  geometry 10,50, 190, 30;
                  title "An Advanced EML";
                  on mousedown
                  {
                        load "Demo_Job.eml";
                  }
            }

            /*
            ** THIS DUMMY BUTTON WILL ENABLE THE EXIT ICON
            */
            button btn_cancel
            {
                  size 0,0;
                  on mousedown
                  {
                        unload;
                  }
            }
      }

      on startup
      {
            display frm_toolbox;
      }
}
```

Then you can load this toolbox.eml from **<IMAGINE_HOME>\scripts\tk_iconpanel.inc** as mentioned previously:

```
button btn_Toolkit
{
      icon "toolkit.ico";
      title "IMAGINE\nTOOLKIT";
      on mousedown
      {
            load "toolbox.eml";
      }
}
```

Making a Menu

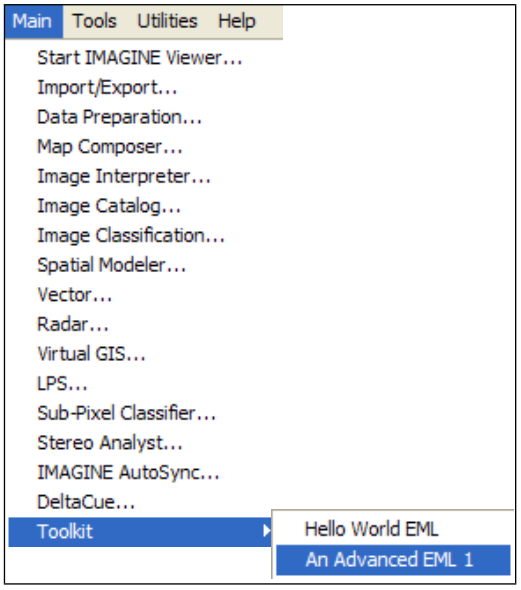
While a button on the icon panel provides a convenient mechanism for accessing custom EML scripts, there may not be enough room on the icon panel for all of our EML scripts. An alternative approach is to add a **menu** to the icon panel. The general syntax for a menu in EML is as follows:

```
menu <menuname> "<menutitle>"
{
      <menuoption1> "<optionititle>"
      {
            (actions for option 1)
      }
      <menuoption2> "<option2title>"
      {
            (actions for option 2)
      }
      ...
}
```

You may copy the **<IMAGINE_HOME>\scripts\tk_mainmenu.inc** to **<IMAGINE_HOME>\scripts\ntx86\tk_mainmenu.inc**, and add your own sub menu for Toolkit there:

```
menu tk_mainmenu "Toolkit"
{
      EMLDemo1 "Hello World EML"
      {
            load "helloworld.eml";
      }
      EMLDemo2 "An Advanced EML 1"
      {
            load "demo_job.eml";
      }

}
```

The diagram on the right is what the sub menu should look like:



Class Notes:

Section 3: Introduction to IMAGINE SML (legacy) and Modeler Python libraries

Section objective:

This section studies the basic syntax of SML and basic usage of IMAGINE Spatial modeler Python library. You will also learn how to call SML & Python model from EML script.

Introduction of SML (legacy)

The ERDAS Spatial Modeler Language (SML) is a spatial analysis script language. SML scripts can be generated automatically from the IMAGINE Spatial Modeler application. The Spatial Modeler provides a graphical interface for creating image processing and GIS analysis routines. When these models are converted to SML scripts, you can execute them without the need to access the graphical interface**. SML scripts also permit model inputs and outputs to be defined as command line parameters, which further enhances the automation it offers. Finally, SML provides iterative capabilities not available in the graphical Spatial Modeler application.

Note: *While graphical spatial models (***.gmd** files) can be converted to SML scripts (***.mdl** or ***.pmdl** files), the reverse process is not possible*

When you run a model via the graphical interface in the Spatial Modeler, the model itself is converted to a temporary SML script, which is then executed by the modeler program. This temporary script is deleted as soon as the model finishes running. The "**Process/Generate Script...**" Menu option can be used to automatically generate a permanent SML script. This menu option is depicted in below.

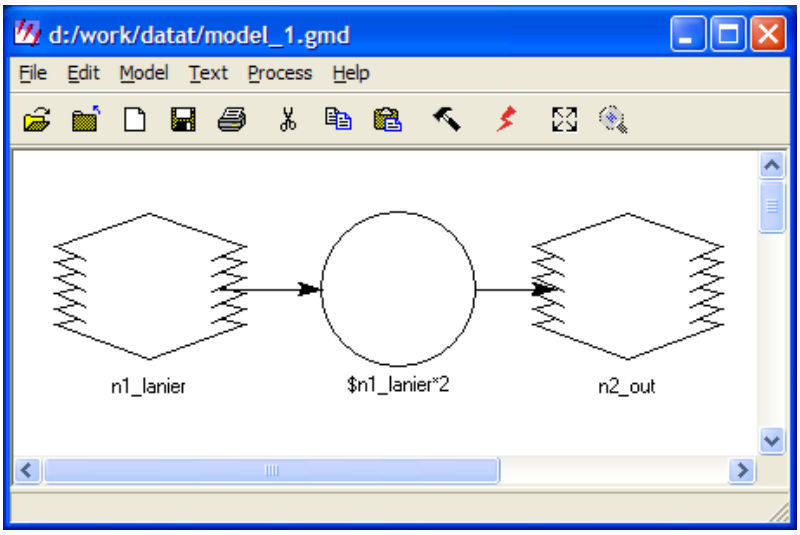
Note that if you become very comfortable with SML, you can actually use a text editor to create new SML scripts. However, it is generally wise to use the automatic script generation option initially to prevent syntax errors. You can then use a text editor to hand-edit these scripts if you wish to change certain default settings associated with automatic script generation.

Exercise 1: Your first SML Script

Exercise Objective:

In this exercise you will write a ERDAS Spatial Modeler Language (SML) script, and will learn basic syntax and rules.

The following figure shows a graphic model ("**model_1.gmd**") from IMAGINE Model Maker. This model will simply multiply the digital values from an input image by 2, and output the result to a new image.



Below is an automatically generated SML script (**model_1.mdl**). This will provide you with a basic understanding of the contents and syntax of these SML scripts.

Code Snippet (Sec3_01): Your first SML script (model_1.mdl)

```
COMMENT "Generated from graphical model: d:/work/datat/model_1.gmd";
#
# set cell size for the model
#
SET CELLSIZE MIN;
#
# set window for the model
#
SET WINDOW UNION;
#
# set area of interest for the model
#
SET AOI NONE;
#
# declarations
#
Integer RASTER n1_lanier FILE OLD NEAREST NEIGHBOR AOI NONE "d:/work/data/lanier.img";
Integer RASTER n2_out FILE DELETE_IF_EXISTING IGNORE 0 ATHEMATIC 8 BIT UNSIGNED INTEGER
"d:/work/datat/out.img";
#
# function definitions
#
n2_out = $n1_lanier*2;
QUIT;
```

Code Explanation:

Comments

Comments in SML are similar to EML. Any line that begins with a **#** character is considered a comment line, and will be ignored by the Modeler. An exception is the Macro Definitions statement, which begins with **#define**. Comments can also be on lines with valid statements. Any text after a **#** is a comment (unless **#** is followed by **define**).

Comment lines can be embedded anywhere within the model. A comment does not need to end with a semicolon. However, if a comment is on the same line as a statement, the statement must end with a semicolon, and the **#** character must follow the semicolon. Blank lines are also ignored by the Modeler.

You may also specify comments using the character sequences **/*** and ***/**. Any text which is between **/*** and ***/** is ignored by the modeler. Comments delimited by **/*** and ***/** may span multiple lines.

Below is an example about comments in SML:

```
#
# THIS IS COMMENT
#
```

```
/*
** THIS IS COMMENT TOO
*/
```

Statements

Notice that all non-comment lines end with a semicolon (**;**). This is an important syntax rule in SML. It tells the SML interpreter that the SML statement is complete and ready for processing. If you neglect to include the semicolon in your SML statements, your SML scripts will produce errors.

Setting the processing area and pixel resolution

The first three SML statements in the example script determine the processing area and pixel resolution of the model. In automatically generated SML scripts, all three parameters are always set in the same way.

```
#
# set cell size for the model
#
SET CELLSIZE MIN;
```

The **CELLSIZE** parameter determines the pixel resolution of the model. In automatically generated scripts, **CELLSIZE** is always set to **MIN**. This means that if a model has two input rasters, then the processing resolution of the model will be the minimum of the pixel resolutions of these rasters. That is, if one of the input rasters has 20 meter resolution, and the other has 30 meter resolution, the model will generate an output raster with 20 meter resolution. In order to do this, it will resample the 30 meter resolution input raster to 20 meters for processing purposes.

```
#
# set window for the model
#
SET WINDOW UNION;
```

The **WINDOW** parameter determines the extent of the processing area. If the model produces an output raster, its extent is also determined by the model **WINDOW**. In automatically generated SML scripts like the one above, the **WINDOW** area is always set to **UNION**. This means that the extent of the processing area will consist of the union of all input layers. So, if a model takes five non-overlapping input layers, the processing area will accommodate the areas of all five inputs.

```
#
# set area of interest for the model
#
SET AOI NONE;
```

The third parameter setting in an automatically generated SML script determines the area of interest (**AOI**), or the subset of the overall processing area which will actually undergo processing. In automatically generated SML scripts, **AOI** will always be set to **NONE**. This means that all pixels within the defined **WINDOW** will be processed and will appear in the output raster.

CELLSIZE, **WINDOW**, and **AOI** all have alternative settings. However, these settings require hand-editing of SML scripts.

Declaring Model Variables

After the processing area and pixel resolution for the model are set, the model variables are declared. The example model contains only two variables both of which are raster images. One is an input raster and the other is an output raster.

```
#
# declarations
#
Integer RASTER n1_lanier FILE OLD NEAREST NEIGHBOR AOI NONE
"d:/work/data/lanier.img";
Integer RASTER n2_out FILE DELETE_IF_EXISTING IGNORE 0 ATHEMATIC 8 BIT UNSIGNED INTE-
GER "d:/work/datat/out.img";
```

Let's take a look at these two declarations. First note that each declaration consists of only one line. These declarations appear to consist of more than one line merely because the text lines are too long to fit on a single line. But if you look carefully, you will see that the above declarations consist of only two SML statements. Note that there is a single semicolon to denote the end of each of these two statements.

The format of the declaration of the **input** raster is as follows:

```
<DATATYPE> RASTER <NAME> FILE <FILE PARAMETERS> <LAYERNAMES>;
```

Where:

<DATATYPE> indicates the internal representation of the raster data in the model. In the example model, the input raster pixels values will be represented as integers

RASTER indicates that the object type of this variable is raster. Other valid object types are **VECTOR**, **TABLE**, **MATRIX**, **SCALAR**.

<NAME> is the variable name. This is the name the model will use when processing this particular raster object. In automatically generated SML scripts, variable names have the following format:

n<#>_<rootname>

The value of <**#**> depends on when the raster object was placed in the model. In our example script, the value of <**#**> is 1 because this raster object was the first object placed in the graphical interface of the Spatial Modeler. The value of <**rootname**> is set according to the root name of the input file. Because the input file for the example model is lanier.img, the root name is **lanier**. Thus, the variable name is **n1_lanier** in this particular case.

FILE merely indicates that the variable is a file.

<FILE PARAMETERS> provide information about the file. In this case, three parameters are listed:

OLD indicates that the file already exists.

NEAREST NEIGHBOR indicates the interpolation method to use if the value of **CELLSIZE** requires this file to be resampled for processing purposes.

AOI NONE indicates that the entire file should be processed as opposed to a subset of the file. This parameter has been set to **NONE** because we did not specify an area of interest (AOI) when

we selected the input image via the graphical interface. If we had defined an area of interest for the input raster, **AOI** would be set to the name of the file containing the subset information. Note that the output raster would be the same size as it would be if **AOI** were set to **NONE**. But only pixels within the defined **AOI** would have values in the output raster. All other pixel values within the processing **WINDOW** would be set to zero in the output raster.

<LAYERNAMES> represents the layers of the input raster file which should be made available to the model. In automatically generated SML scripts, either all layers of an input raster file can be used for a model variable or individual layers can be represented as different variables. Thus, file name (including the full path to the file and layer if an individual layer is selected via the graphical interface) will appear in automatically generated SML scripts. You can alternatively select a subset of two or more layers of an input file for an SML script variable. However, this requires hand-editing.

The format for the **output** raster declaration is the same but uses different file parameters.

```
<DATATYPE> RASTER <NAME> FILE <FILE PARAMETERS> <LAYERNAMES>;
```

Where:

DELETE_IF_EXISTING indicates that if the file named as the output raster file already exists, it should be deleted before the model is executed. This file parameter appears in our example file because we selected the "**Delete If Exists**" option when we selected our output file name via the graphical interface. If we had not selected this option, the file parameter in this case would be **NEW**. When **NEW** is specified, the model will not run if a file with the same name as our output file already exists.

USEALL indicates that all pixel values in the output image should be used in computing its statistics. This file parameter appears because we did not specify an "**Ignore**" value when we selected our output image name in the graphical interface.

> **IGNORE** 0 lets you to specify an "**Ignore**" value, this file parameter would be **IGNORE** <**value**>.

ATHEMATIC indicates that the output raster will be designated as continuous as opposed to a thematic. This file parameter appears in our example model because we used the default "File Type" setting when we selected our output image name via the graphical interface. If we had set "File Type" to thematic, this file parameter would be **THEMATIC** in our SML script.

16 BIT UNSIGNED INTEGER determines the pixel type of the output raster file. Note that this is independent of <**datatype**>. However, if the output pixel type allows for a smaller range of values than <**datatype**>, then any pixel values exceeding the valid range of the output pixel type will be set to the maximum value of its range. For example, if our process raster data has a range of values from 0 to 800, and the output pixel type is specified as **UNSIGNED 8-BIT INTEGER**, then all pixel values exceeding 255 will be set to 255 in the output raster. This means information will be lost in the output raster. Thus, it is important to select output types that can accommodate the full range of processed values.

Declaring functions

Let's take a look at function declaration in our example script.

```
#
# function definitions
#
n2_out = $n1_lanier*2;
```

Once the model variables are declared, the model functions are defined. All functions constructed via the Spatial Modeler graphical interface consist of assignment operations in which an output variable is assigned to be equal to a function of one or more input variables. In this case, the output raster file represented by the variable **n2_out** is assigned the value of two times the input raster variable represented by **n1_lanier**.

Note: *The **$** is optional! Previous versions of the modeler required variable references to be prefaced with the **$** character. This is now optional. In the current version, any valid expression may be preceded by **$**, which will be ignored.*

You can rewrite the above code like this:

```
#
# function definitions
#
n2_out = n1_lanier*2;
```

Exiting the Script

After all model functions have been defined, the **QUIT** statement is used to indicate the end of the script. This tells the interpreter that it should not attempt to look for any additional instructions. All SML scripts should exit with the **QUIT** statement.

```
QUIT;
```

Class Notes:

Exercise 2: Load SML Model from EML

Exercise Objective:

This exercise will let you run your SML model (***.mdl or *.pmdl**) from the IMAGINE command line and EML script.

We will use arguments instead of real file name, so our SML model is ready to accept arguments from command line or EML script. The following code will accept input argument:

Code Snippet (Sec3_02): EML Script with argument (demo.mdl)

```
# set cell size for the model
#
SET CELLSIZE MIN;
#
# set window for the model
#
SET WINDOW UNION;
#
# set area of interest for the model
#
SET AOI NONE;

/*
**************************************************************************
**
** AN SIMPLE SML SCRIPT
** MULTIPLY SINGLE LAYER BY AN NUMBER
**          ARG1 = INPUT FILE NAME
**          ARG2 = BAND INDEX ( 1, 2, 3, ...)
**          ARG3 = MULTIPILER
**          ARG4 = OUTPUT FILE NAME
**
**************************************************************************
*/

/*
** MAKE SURE THERE IS 4 ARGUMENTS
*/
IF (argcount != 4) { QUIT; }

/*
```

```
** VARIABLE DECLARATION
*/
INTEGER RASTER in FILE OLD NEAREST NEIGHBOR AOI NONE ARG1;
INTEGER RASTER out FILE DELETE_IF_EXISTING ARG4;


/*
** DISPLAY INPUT ARGUMENT
*/
SHOW "----START PROCESS----";
SHOW "INPUT FILE NAME:",     ARG1;
SHOW "BAND INDEX:",          ARG2;
SHOW "MULTIPILER:",          ARG3;
SHOW "OUTPUT FILE NAME:",    ARG4;

/*
** MULTIPLY A SINGLE LAYER BY A NUMBER
*/
out = in(arg2) * arg3;


SHOW "----END PROCESS----";
QUIT;
```

Code Explanation:

Implementing Command Line Parameters

Command line arguments can be substituted for any constant value defined in an SML script. Constant values include numeric constants (e.g., numeric values associated with alternative parameter settings for processing area and pixel resolution), and string constants (e.g., strings representing file names of input and output raster files). This substitution is achieved by using the **arg<#>** reserved words where constants would otherwise appear. The **arg<#>** strings take the form **argl, arg2, arg3** and so on. Each string corresponds to a command line argument. The number in the string indicates the position of the argument. Thus, if only one command line argument is defined for an SML script, it must be defined as argl in the SML script.

Related to the **arg<#>** key words is the argcount key word. The argcount key word can be used in an SML script to see how many command line arguments the script has received. This is very useful in models that require several command line arguments. By checking the value of argcount, you can quit the model immediately if the user fails to provide the correct number of arguments.

ARGCOUNT

ARGCOUNT is useful for making sure that the model is executed with the correct number of arguments. In the previous example, we could add as the first line of the model:

```
IF (argcount != 4) { QUIT; }
```

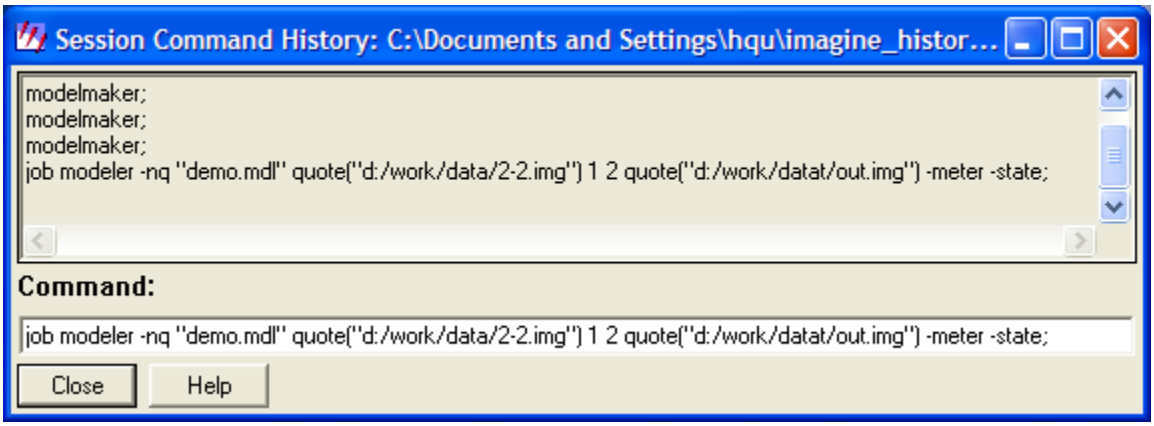
This would cause the model to stop executing after the first line if less than 4 model arguments were included on the command line.

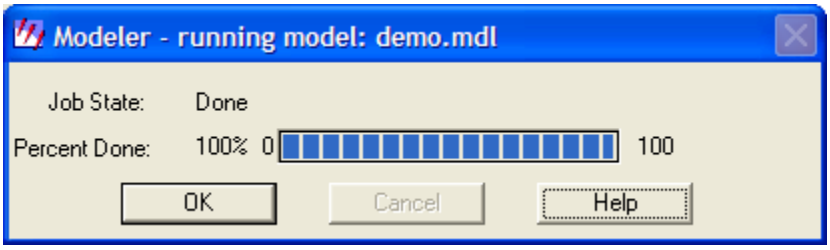
Call demo.mdl from IMAGINE Command line

If you want to multiply the first band of “2-2.img” by 2, you can type the following command into IMAGINE Command line:

```
job modeler -nq "demo.mdl" quote("d:/work/data/2-2.img") 1 2
quote("d:/work/datat/out.img") -meter -state;
```

When you run the SML model from the IMAGINE command line you should see the following dialog boxes





The options used in the command line are:

-NQ option

The Spatial Modeler will automatically enclose certain arguments in double quotes before passing them to the model, unless the **-nq** option is included on the command line. Any argument will be

enclosed in quotes before being passed to the model, unless it meets one of the following conditions:
• The argument already starts and ends with the double quote character (").
• The argument is a valid floating point number.
• The argument contains only letters, numbers, or underscore (_) characters.
• The argument does not contain any letters, numbers, or underscore characters.

-METER option

The **-m** or **-meter** option causes the Spatial Modeler to print to standard output a message which indicates the progress of the current stage of model execution as a percent of total time for that stage.

-STATE option

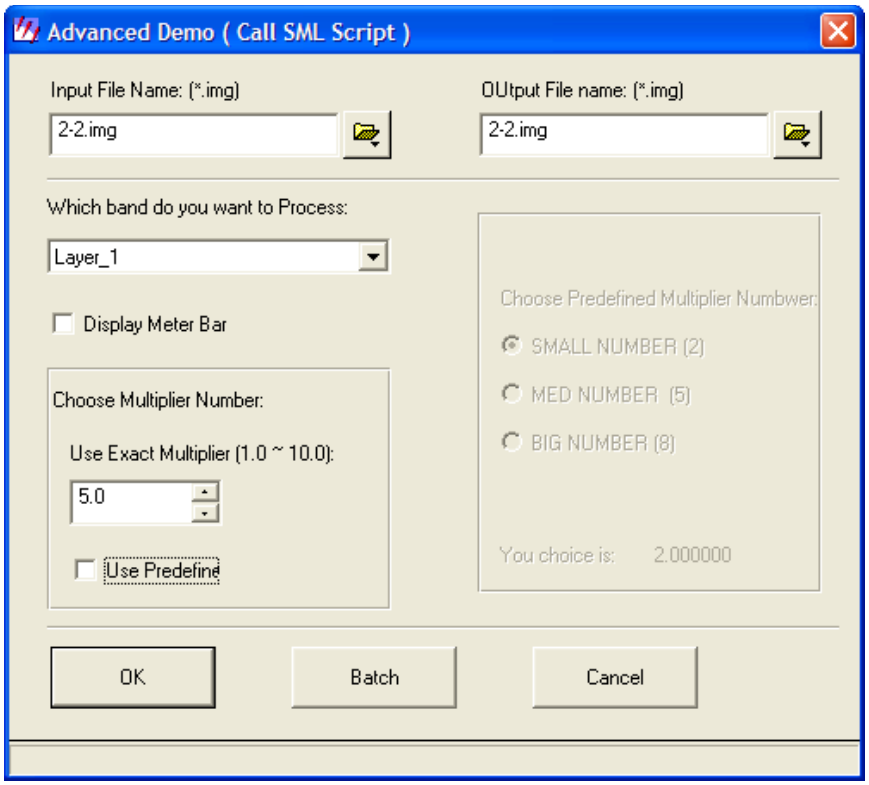
The **-s** or **-state** option causes the Spatial Modeler to print to standard output a status message which indicates the current status of model execution.

Call demo.mdl from EML Script (Demo_SML.eml)

You may find the "**Demo_SML.eml**" in your working folder. Pay attention to the code block that calls the SML model. All arguments are getting their values from the EML frameparts.

```
on pro_ExportJPEG
{
     variable band;
     set band = $pop_bands.GetListIndex() + 1;  # INDEX START FRMO 0, WHILE BAND
START FROM 1.

     /*
     ** CALL SML SCRIPT
     */
     job modeler -nq "demo.mdl"
          quote($fln_input)          # ARG1
          $band                      # ARG2
          $txt_ExactNum              # ARG3
          quote($fln_output)         # ARG4
          -meter
          -state;
}
```

The following fiqure shows the GUI interface of "**Demo_SML.eml**":


Advanced Demo (Call SML Script)
Input File Name: (*.img)
2-2.img
OUtput File name: (*.img)
2-2.img
Which band do you want to Process:
Layer_1
Display Meter Bar
Choose Multiplier Number:
Use Exact Multiplier (1.0 ~ 10.0):
5.0
Use Predefine
Choose Predefined Multiplier Numbwer:
SMALL NUMBER (2)
MED NUMBER (5)
BIG NUMBER (8)
You choice is: 2.000000
OK
Batch
Cancel

Class Notes:

Exercise 3: Your first Python script

Exercise Objective:

This exercise will let you run your Python model (***.py**) from the Windows Command line and EML script.

Section objective:

This section studies the initial setup for IMAGINE Modeler Python libraries and some built-in Python functions. You will also learn how to call Python model from EML script.

Introduction

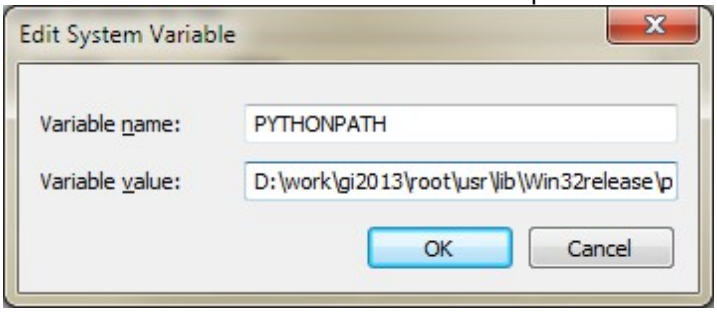
With the 2013 release of the Spatial Modeler, complex GIS processing systems and workflows can now be very quickly and efficiently developed. Integration of several software packages and operators is now easier than ever before. In the following book, we showcase the new abilities of the ERDAS Spatial Modeler with a view to quickly developing and deploying complete end-to-end GIS workflows. Our aim is to enable you, the reader, to extract actionable information from raw data faster than ever before.

Note:** While the New graphical spatial models (.gmdx** files) can be converted from legacy spatial models (***.gmd**), the reverse process is not possible. In IMAGINE 2013, it is impossible to export Python script directly from spatial modeler.*

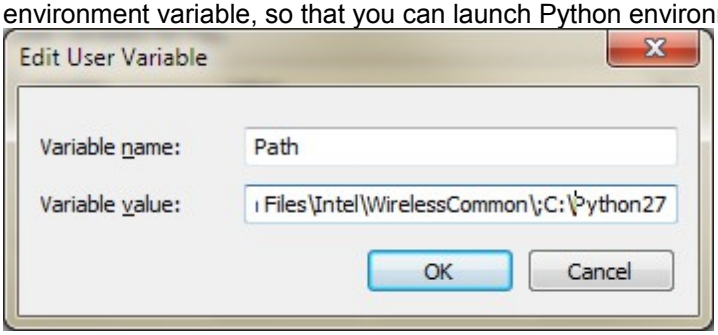
Before we go into using spatial models and operators within python, let us talk about initial setup for IMAGINE Modeler Python libraries. Create Windows System Environment called “PYTHONPATH”.

Launch “System Properties”, and then click “Environment Variables...”, Create a new system/user variable, and point to $IMAGINE_HOME\usr\lib\win32release\python

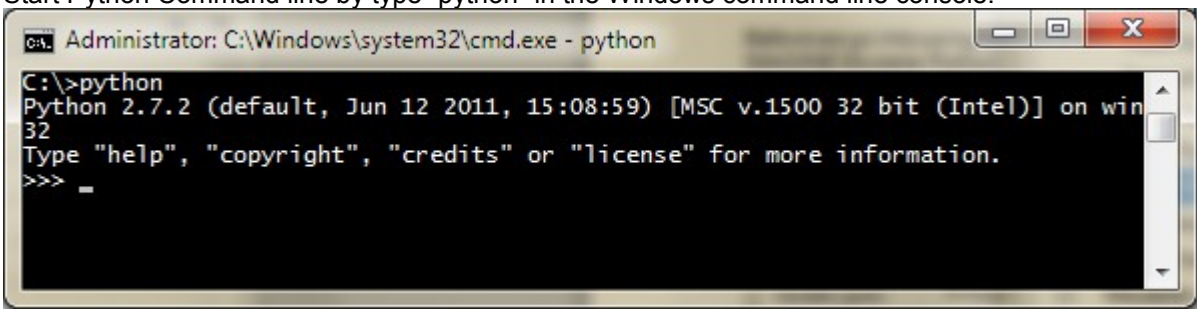
PYTHONPATH = C:\ERDAS\ERDAS Desktop 2013\\usr\lib\Win32Release\python



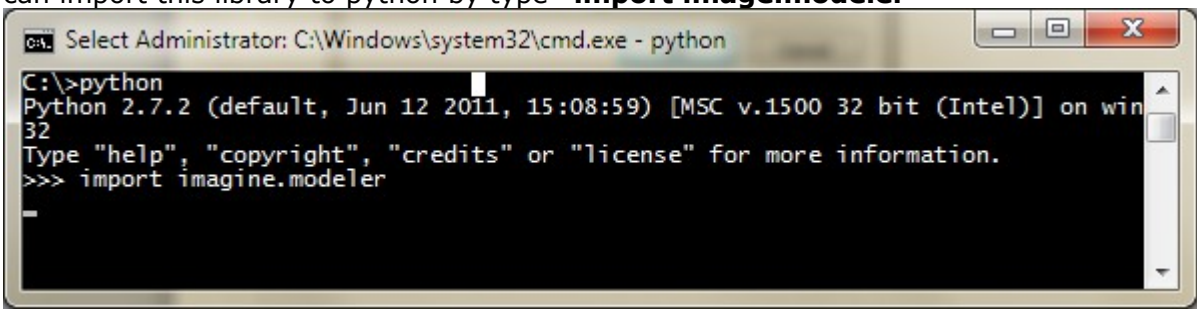
If you installed Python 2.7, then you also need to add the path of python.exe to system **PATH** environment variable, so that you can launch Python environment from command line.



Start Python Command line by type "python" in the Windows command line console.

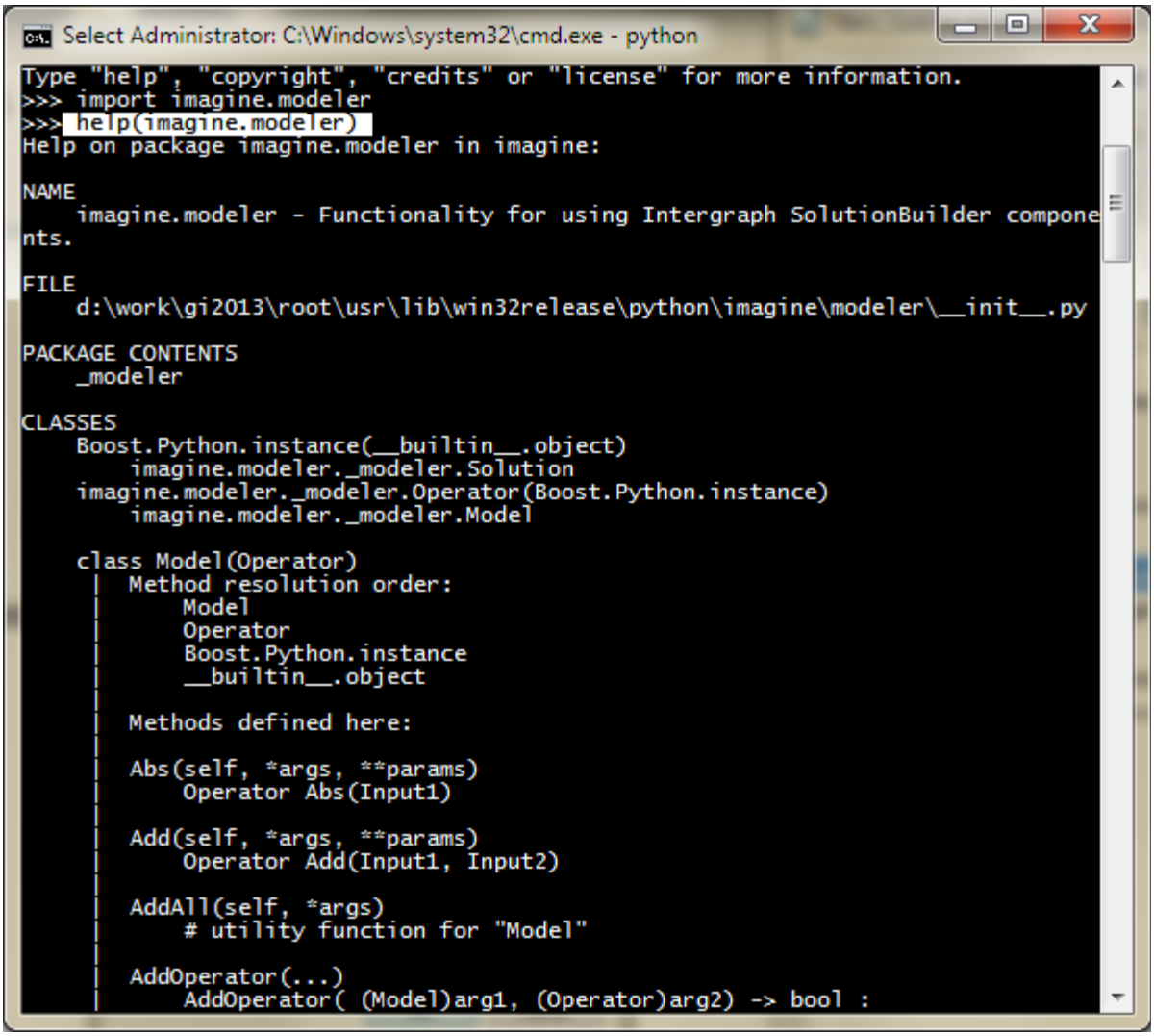

Administrator: C:\Windows\system32\cmd.exe - python
C:\>python
Python 2.7.2 (default, Jun 12 2011, 15:08:59) [MSC v.1500 32 bit (Intel)] on win
32
Type "help", "copyright", "credits" or "license" for more information.
>>>

The core Python libraries that introduced by IMAGINE is called **"imagine.modeler",** you can import this library to python by type **"import image.modeler"**


Select Administrator: C:\Windows\system32\cmd.exe - python
C:\>python
Python 2.7.2 (default, Jun 12 2011, 15:08:59) [MSC v.1500 32 bit (Intel)] on win
32
Type "help", "copyright", "credits" or "license" for more information.
>>> import imagine.modeler

If you want to know more details about imagine.modeler package, you can type help(imagine.modeler) inside python environment.

Note: If you want to see the complete help, you can export help to an ASCII file by type the following command in WINDOWS command line console:
C:\Python27>python.exe .\lib\pydoc.py imagine.modeler >c:\modeler_help.txt

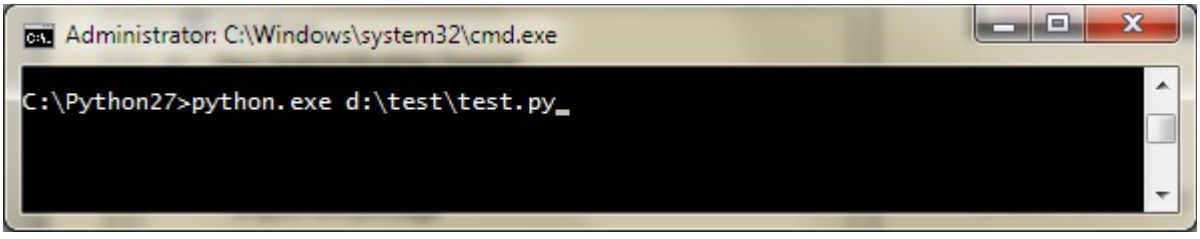

Select Administrator: C:\Windows\system32\cmd.exe - python
Type "help", "copyright", "credits" or "license" for more information.
>>> import imagine.modeler
>>> help(imagine.modeler)
Help on package imagine.modeler in imagine:
NAME
imagine.modeler - Functionality for using Intergraph SolutionBuilder compone
nts.
FILE
d:\work\gi2013\root\usr\lib\win32release\python\imagine\modeler__init__.py
PACKAGE CONTENTS
_modeler
CLASSES
Boost.Python.instance(__builtin__.object)
imagine.modeler._modeler.Solution
imagine.modeler._modeler.Operator(Boost.Python.instance)
imagine.modeler._modeler.Model
class Model(Operator)
Method resolution order:
Model
Operator
Boost.Python.instance
__builtin__.object
Methods defined here:
Abs(self, *args, **params)
Operator Abs(Input1)
Add(self, *args, **params)
Operator Add(Input1, Input2)
AddAll(self, *args)
# utility function for "Model"
AddOperator(...)
AddOperator((Model)arg1, (Operator)arg2) -> bool :

First Model

Create an ASCII file named test.py, and type the following python code. What this script does is to multiply the input raster by 2.

```
#
# Import IMAGINE spatial modeler library
#
from imagine import modeler

#
# Define model
#
m = modeler.Model()

#
# Define input raster object
#
i = m.RasterInput("d:/test/2-2.img", "u8", "Nearest Neighbor")

#
# Use "Multiply" operator
#
o = m.Multiply(i,2)

#
# Define output raster object
#
m.RasterOutput(o, "d:/test/2-2_output.img", "u8", Thematicity=modeler.Thematicity.-
continuous)

#
# Run model
#
m.Execute()
```

Save the file to d:\test\test.py, and run the following command line, and you will find the newly created 2-2_output.img file. You can open the image in IMAGINE, and check the DN values.



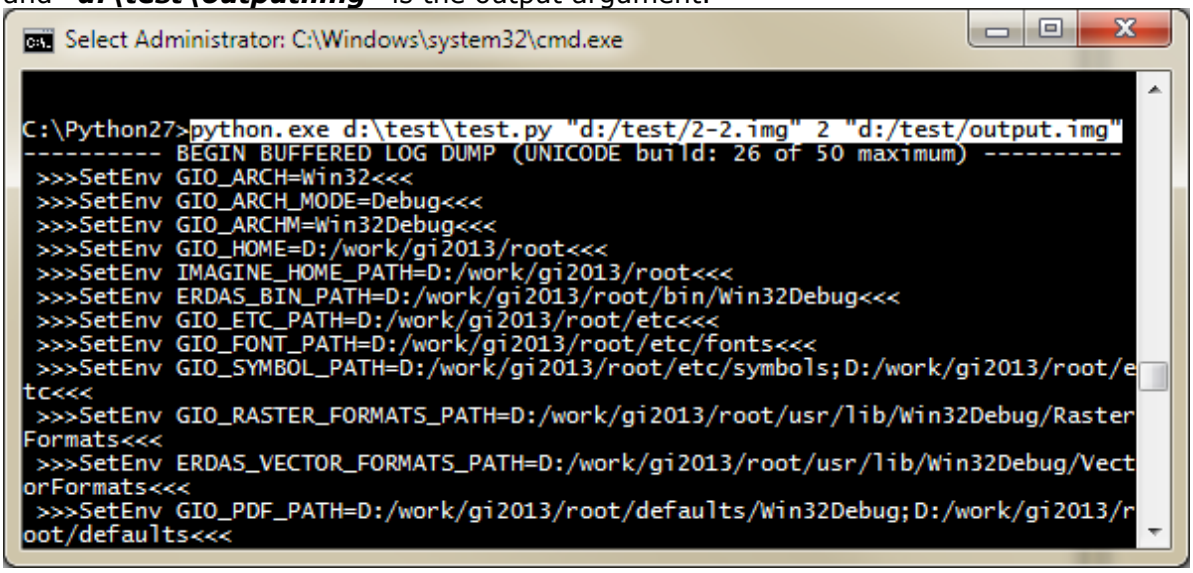
Add argument to the model

Now let's add argument to the model, so user need to provide 3 arguments:
input image path, multiplier, and output image path.

Code Snippet (Sec3_03): Python Script with argument (demo.mdl)

```
#
# Import IMAGINE spatial modeler library
#
from imagine import modeler

#
# Import Python built-in sys library to handle commandline argument
#
import sys

#
# Parse the command line, so first three arguments will be recognized as input, mul-
tiplier and ouput
#
arg1_input =sys.argv[1]  # file path to input image
arg2_multiplier =sys.argv[2] # multiplier
arg3_output = sys.argv[3] # file path to output image

#
# Define model
#
m = modeler.Model()

#
# Define input raster object
#
i = m.RasterInput(arg1_input, "u8", "Nearest Neighbor")

#
# Use "Multiply" operator
#
o = m.Multiply(i,arg2_multiplier)

#
# Define output raster object
#
m.RasterOutput(o, arg3_output, "u8", Thematicity=modeler.Thematicity.continuous)

#
# Run model
#
m.Execute()
```

Now you can call your model with arguments. For example, you can type the following command line.
"d:\test\2-2.img" is the input argument,
2 is the multiplier,
and ***"d:\test\output.img"*** is the output argument.

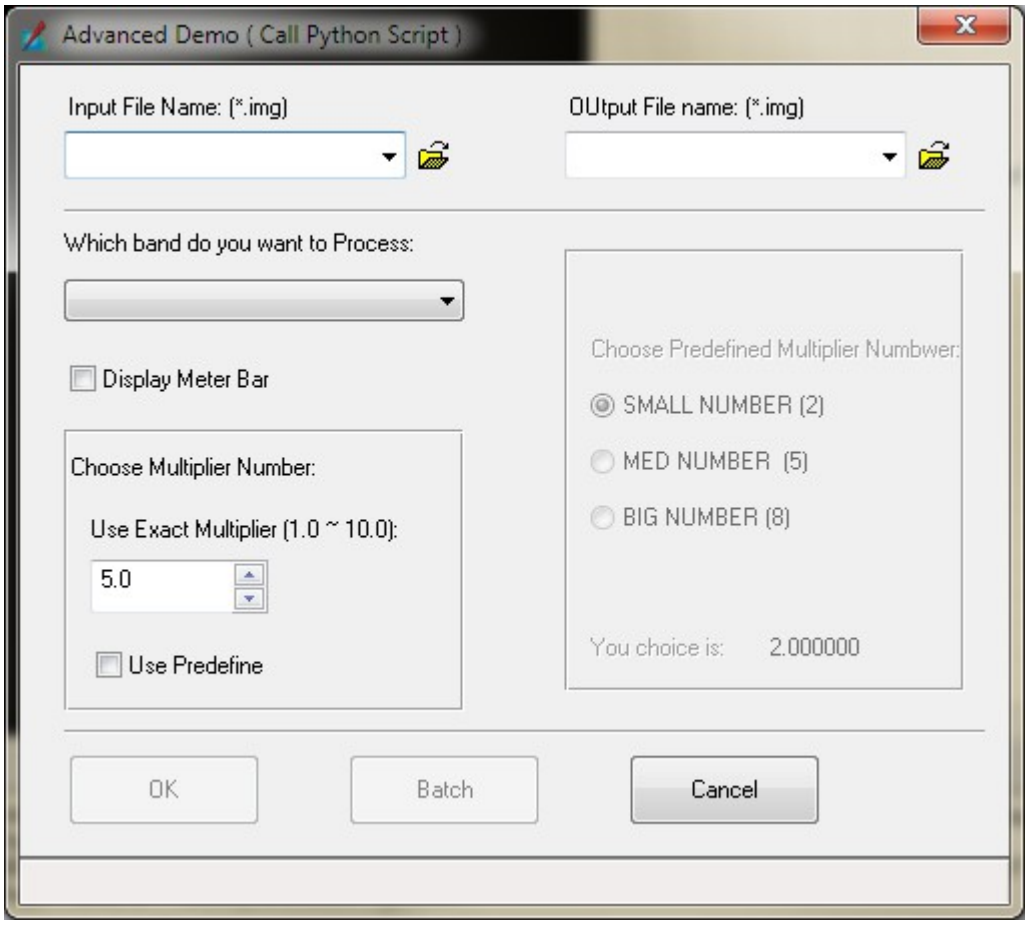

Select Administrator: C:\Windows\system32\cmd.exe
C:\Python27>python.exe d:\test\test.py "d:/test/2-2.img" 2 "d:/test/output.img"
---------- BEGIN BUFFERED LOG DUMP (UNICODE build: 26 of 50 maximum) ----------
>>>SetEnv GIO_ARCH=Win32<<<
>>>SetEnv GIO_ARCH_MODE=Debug<<<
>>>SetEnv GIO_ARCHM=Win32Debug<<<
>>>SetEnv GIO_HOME=D:/work/gi2013/root<<<
>>>SetEnv IMAGINE_HOME_PATH=D:/work/gi2013/root<<<
>>>SetEnv ERDAS_BIN_PATH=D:/work/gi2013/root/bin/Win32Debug<<<
>>>SetEnv GIO_ETC_PATH=D:/work/gi2013/root/etc<<<
>>>SetEnv GIO_FONT_PATH=D:/work/gi2013/root/etc/fonts<<<
>>>SetEnv GIO_SYMBOL_PATH=D:/work/gi2013/root/etc/symbols;D:/work/gi2013/root/etc<<<
>>>SetEnv GIO_RASTER_FORMATS_PATH=D:/work/gi2013/root/usr/lib/Win32Debug/RasterFormats<<<
>>>SetEnv ERDAS_VECTOR_FORMATS_PATH=D:/work/gi2013/root/usr/lib/Win32Debug/VectorFormats<<<
>>>SetEnv GIO_PDF_PATH=D:/work/gi2013/root/defaults/Win32Debug;D:/work/gi2013/root/defaults<<<

Call test.py from EML Script (Demo_Python.eml)

You may find the "**Demo_SML.eml**" in your working folder. Pay attention to the code block that calls the Python model. All arguments are getting their values from the EML frameparts.

```
on pro_ExportJPEG
        {
                variable band;
                variable a;
                variable b;
                variable c;
                set band = $pop_bands.GetListIndex() + 1;  # INDEX START FRMO 0,
WHILE BAND START FROM 1.

                /*
                ** CALL Python SCRIPT
                */
                set a=quote($fln_input);
                set c=quote($fln_output);
                system cmd "/c" python "d:/test/test.py" $a $txt_ExactNum $c;

        }
```

The following fiqure shows the GUI interface of "**Demo_Python.eml**":


Advanced Demo (Call Python Script)
Input File Name: (*.img)
OUtput File name: (*.img)
Which band do you want to Process:
Display Meter Bar
Choose Multiplier Number:
Use Exact Multiplier (1.0 ~ 10.0):
5.0
Use Predefine
Choose Predefined Multiplier Numbwer:
SMALL NUMBER (2)
MED NUMBER (5)
BIG NUMBER (8)
You choice is: 2.000000
OK
Batch
Cancel

Class Notes:

Section 4: Getting Started with IMAGINE C Toolkit

Section objective:

This section:

- explains the basic IMAGINE directory structure and environment variables,
- introduces IMAGINE Developers' Toolkit,
- explains how to set up the working environment
- gives a brief description of the Toolkit packages.

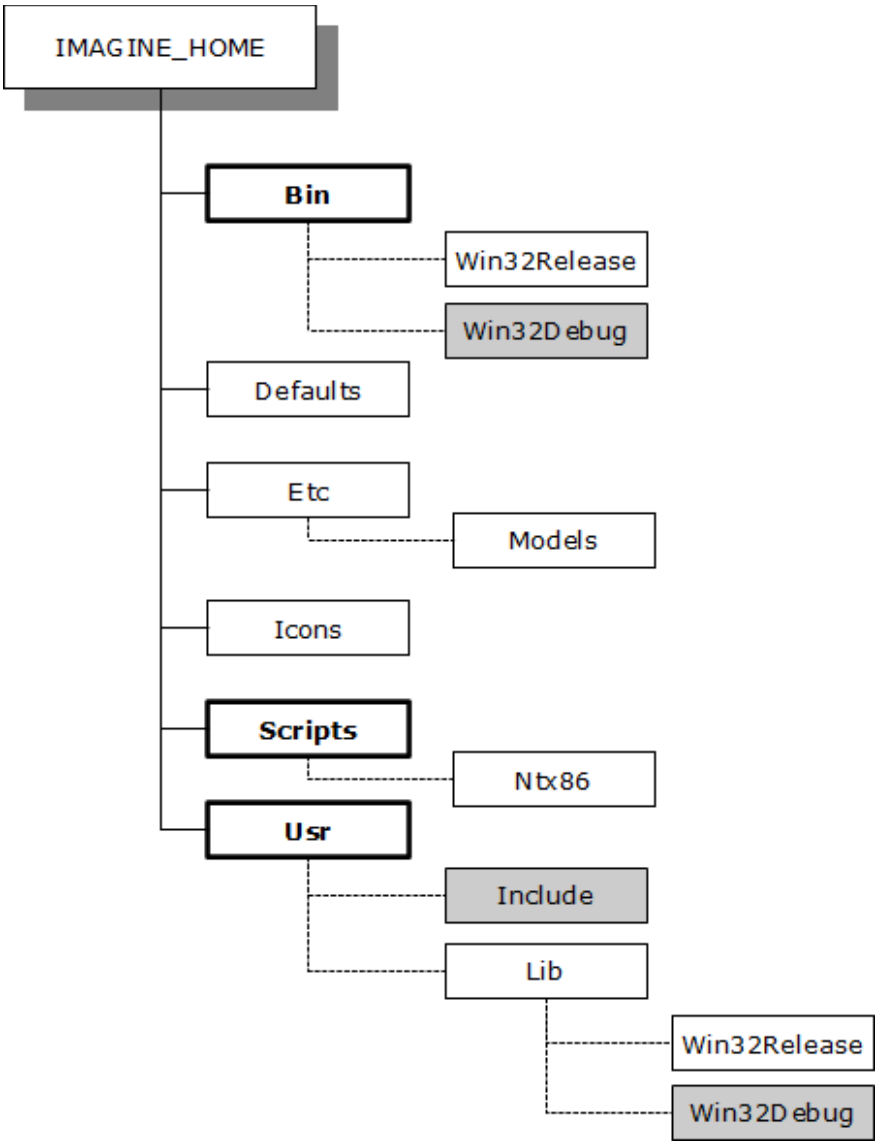
IMAGINE Installation Structure

This is not an all-inclusive directory of ERDAS IMAGINE® but it does contain any of the most important aspects of an IMAGINE installation structure, and includes most of the directories and paths that concern developers.

You should be familiar with most of the folders listed in the structure map:
<IMAGINE_HOME>\Defaults folder contains all preference database (i.e., ***.pdf**);
<IMAGINE_HOME>\Etc\Models folder contains built-in SML model (i.e., ***.gmd** and ***.pmdl**);
<IMAGINE_HOME>\Icons folder contains all icons for IMAGINE toolbox;
<IMAGINE_HOME>\Scripts folder contains all EML scripts for IMAGINE GUI;
<IMAGINE_HOME>\Scripts\Win32Release folder contains your own EML scripts.

After IMAGINE Toolkit installation, you will found the installer add more folders to IMAGINE installation structure, they are in the grey color.
<IMAGINE_HOME>\Bin\Win32Debug: contains debug version of IMAGINE Core DLLs and EXEs.
<IMAGINE_HOME>\Usr\Include: contains header files (***.h**) of IMAGINE Toolkit C API.
<IMAGINE_HOME>\Usr\Lib\Win32Release: contains ***.lib** for all IMAGINE core dlls, which will be needed at link time when you compile toolkit program.
<IMAGINE_HOME>\Usr\Lib\Win32Debug: also contains debug version of IMAGINE Demand Loaded Libraries, and we will cover this topic at Section 6.

The figure below shows the brief installation structure of IMAGINE, and Toolkit (Grey color).



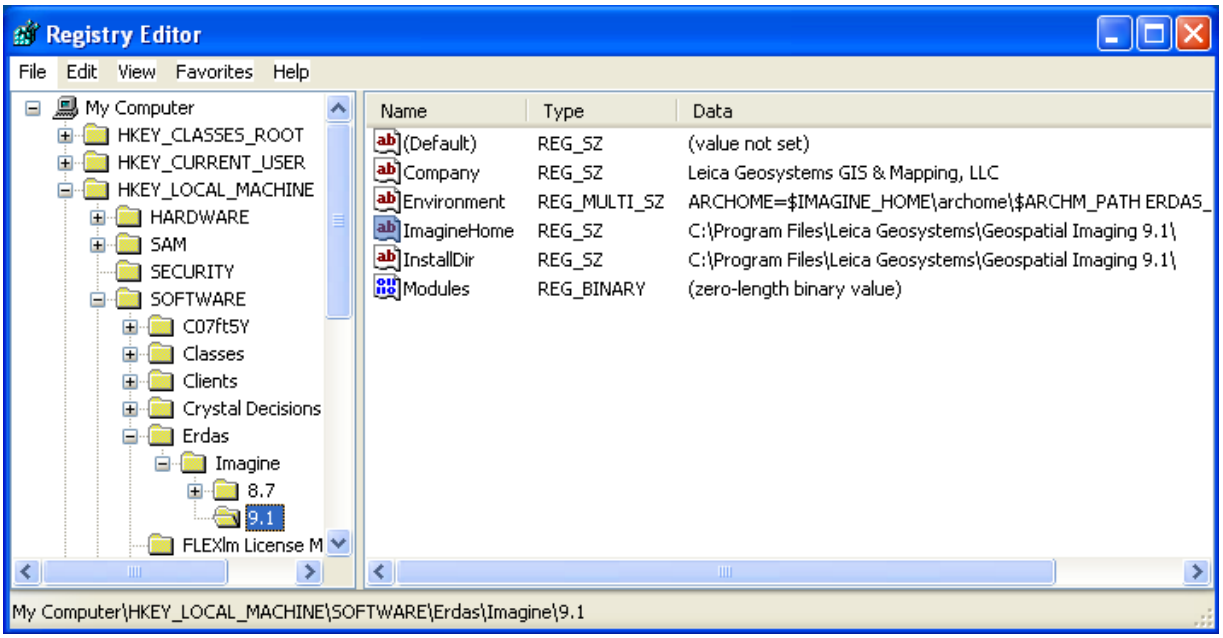
What's the Benefit of debug version of DLLs

Actually the header in the include folder is all you need, you can access all IMAGINE Toolkit APIs with headers. While the debug libraries will allow developers to view the function call stack while debugging, and also provide you extra debug information (i.e., error message in the Session log).

What is <IMAGINE_HOME>

So far, we use **<IMAGINE_HOME>** quite a bite in this book. What is <IMAGINE_HOME>? IMAGINE_HOME is an IMAGINE environment variable. On startup, everything in IMAGINE is referenced to the **$IMAGINE_HOME** environment variable. On Windows platforms, this is set in the registry. UNIX

platforms differ. This means that when IMAGINE starts, all of the library paths, script paths, icon paths… are resolved, based on the installation directory (**<IMAGINE_HOME>**) and the directory structure. The diagram below shows the registry entry for ERDAS IMAGINE. **NOTE**: use c:\Windows\SysWOW64>regedit.exe for 64bit system



IMAGINE_HOME is Unique

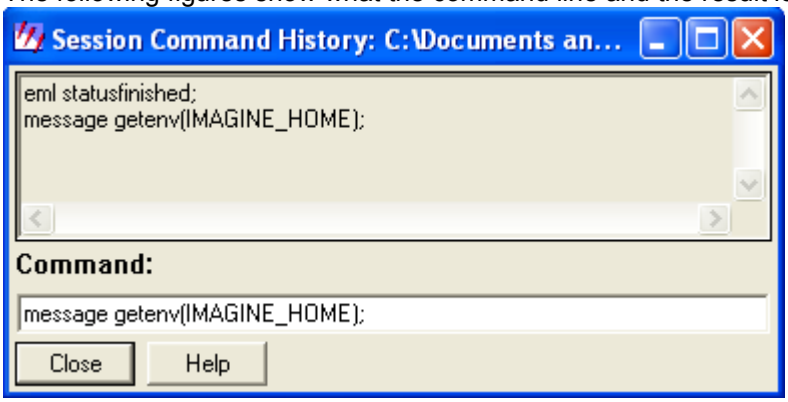
IMAGINE_HOME is unique; you can not expend it like other environment variables.

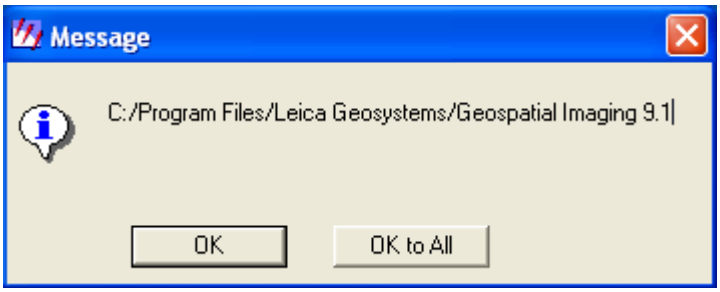
Another way to view IMAGINE Environment Variable

You may use Command line "**message getenv(IMAGINE_HOME)**" to view any IMAGINE environment variable:

```
message getenv(IMAGINE_HOME)
```

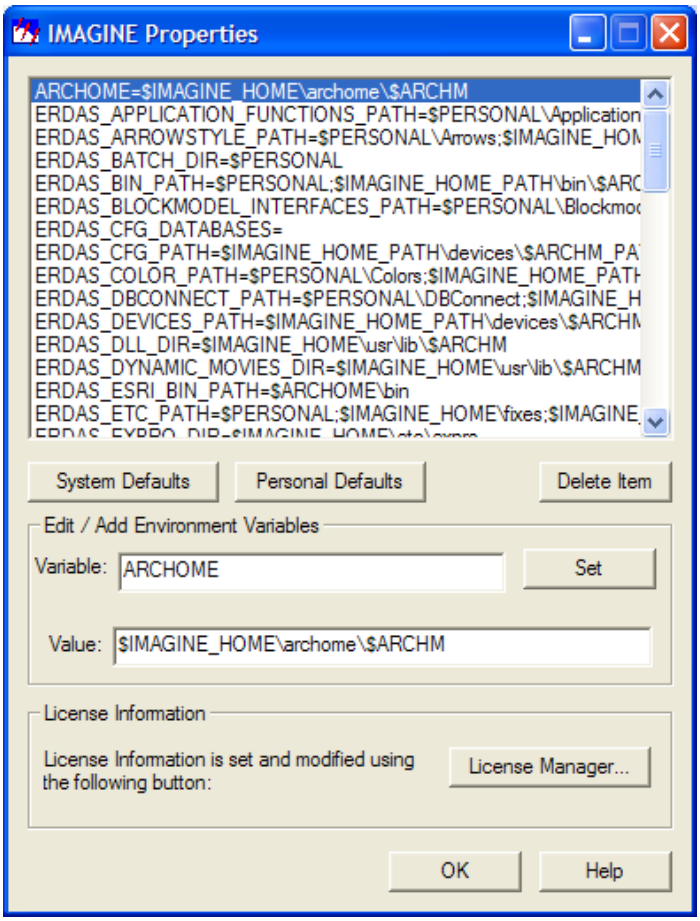
The following figures show what the command line and the result look like.





Other IMAGINE Environment Variables

From the Session pull-down menu, select Properties. The ERDAS IMAGINE Properties dialog will display. You may find all other IMAGINE Environment variables from **Session->Properties.**



Actually you don't need to modify these environment variables, because it can be dangerous to change them. For example, if you change ERDAS_SCRIPT_PATH to "**d:/**", then next time you will not be able to start IMAGINE, because IMAGINE can not find all its EML script for GUI display.

IMAGINE_HOME_PATH is expandable, IMAGINE_HOME is NOT.

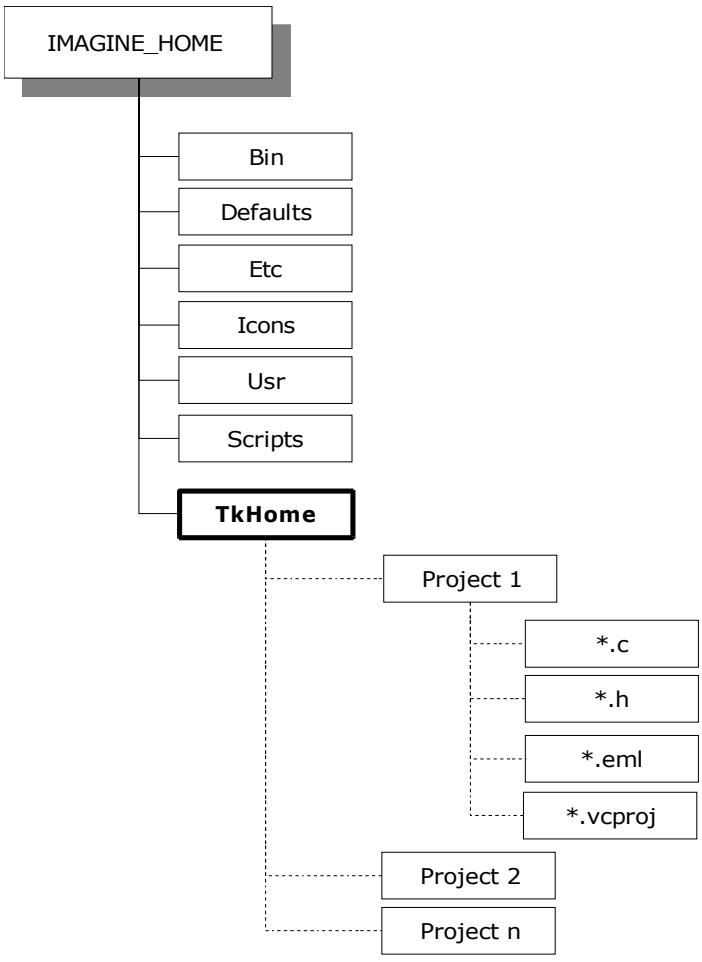
IMAGINE_HOME is unique, while **IMAGINE_HOME_PATH** is expandable. You can expand it to your own working folder, so IMAGINE can find your EML script and EXEs. We will show you how to do that in the next section.

Class Notes:

Setup Working Envionment

After we have the basic understand of how IMAGINE manage its resources, the next question will be where to put your own code (i.e., C code, EML code)? There are two different plans, the first plan will put all your code into **IMAGINE_HOME**, and another plan put your code wherever you want, but need some hacking. We recommend plan1, because it will save your time when porting your code project to different computer, or different version of IMAGINE. You will understand this after you finish the "Setup Micosoft Visual Studio 2008" section.

You should follow the following instruction to orgnize your C code and EML scritps.
Put your Toolkit program under the **IMAGINE_HOME** like the following figure.



Class Notes:

Setup Microsoft Visual Studio 2008 (with SP1)

Make sure to organize your project folder similar to the following structure, otherwise the Microsoft Visual Studio project setting (relative path) may not work.

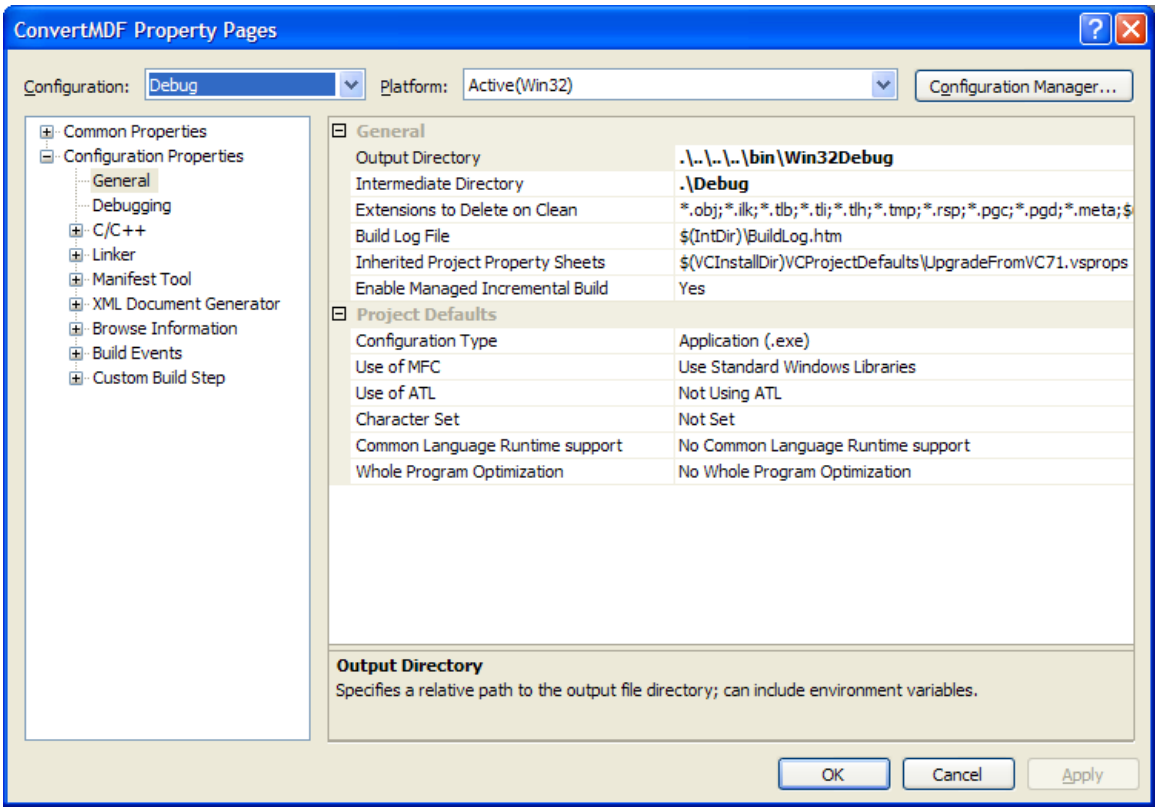
C:\...\ERDAS Desktop 2011
|_etc
|_Bin
|_scripts
|_usr
|_TkHome
|_Project1
|_ Project1.vcproj
|_ Project1.c
|_ Project1.h
|_ Project1.eml

The next step is to modify the Project Settings of your Microsoft Visual Studio 2008.

Debug version

Project settings of Microsoft Visual Studio 2008:

Configuration Properties->General



Change the output directory to the following:

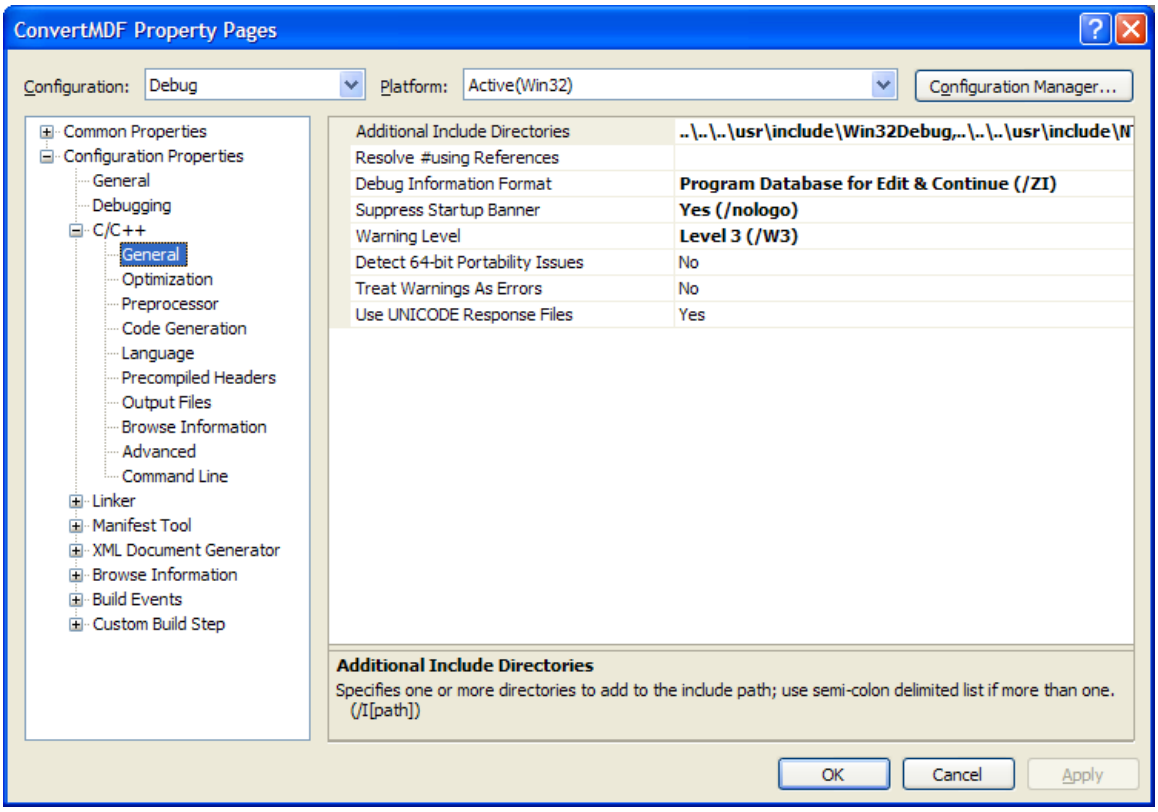
```
Output Directory:
.\..\..\bin\Win32Debug
```

The **".\..\..\bin\Win32Debug\"** folder also contains all the debug version of IMAGINE core dlls. When you run your Toolkit program, Microsoft Visual Studio 2008 compiler will find all core dll (i.e., **elib.dll, eraster.dll, emllib.dll**...) in the same folder as the output exe, and then load them into memory space.
Visual Studio tries to find the DLLs in the following locations.

1. The Windows System Directory
2. The Windows directory
3. The Application local path
4. The directories listed in the path environment variables

In this case, the dlls are in the application local path.

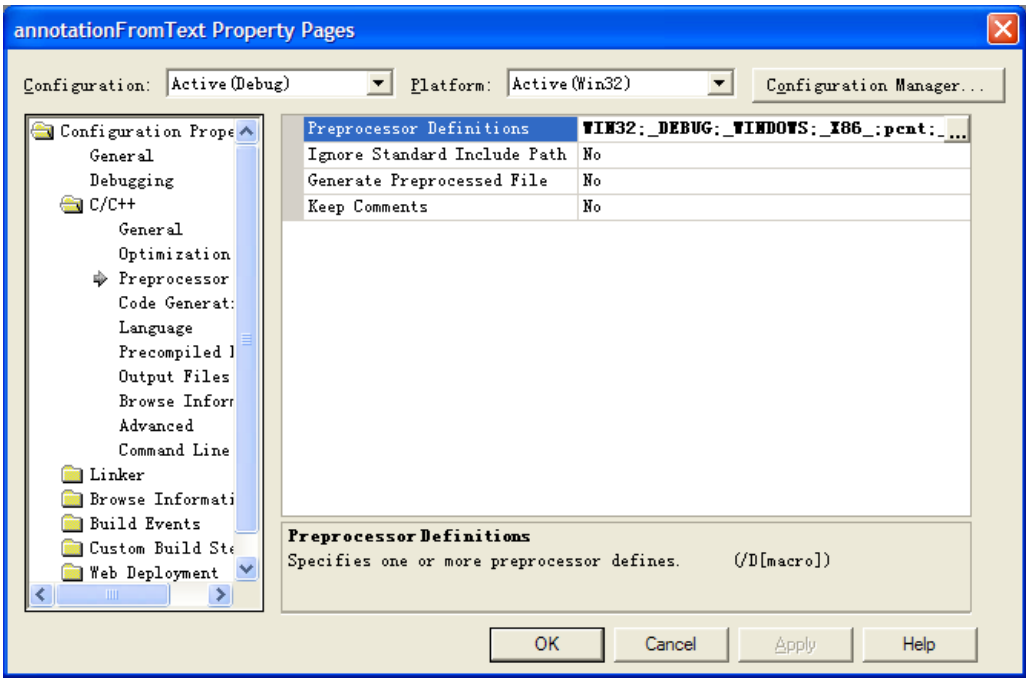
Configuration Properties->C/C++->General



Change the output directory to the following:

```
Additional Include Directories:
.\..\..\usr\include\Win32Debug,.\..\..\usr\include\Win32Release
```

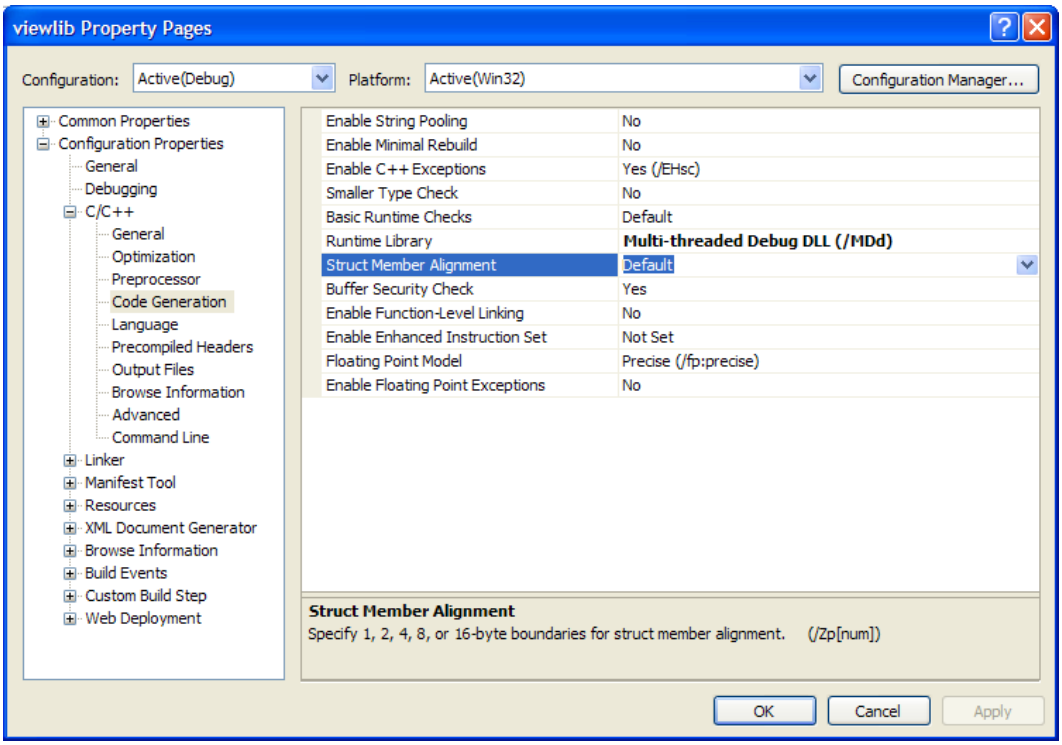
Configuration Properties->C/C++->Preprocessor



Change the Preprocessor Definitions to the following:

```
Preprocessor Definitions:
      WIN32
      _DEBUG
      _WINDOWS
      _X86_
      pcnt
      __STDC__
      i386
      EMSC_IMAGINE8_COMPATIBILITY
      IMAGINE_Toolkit_Packing=8
```

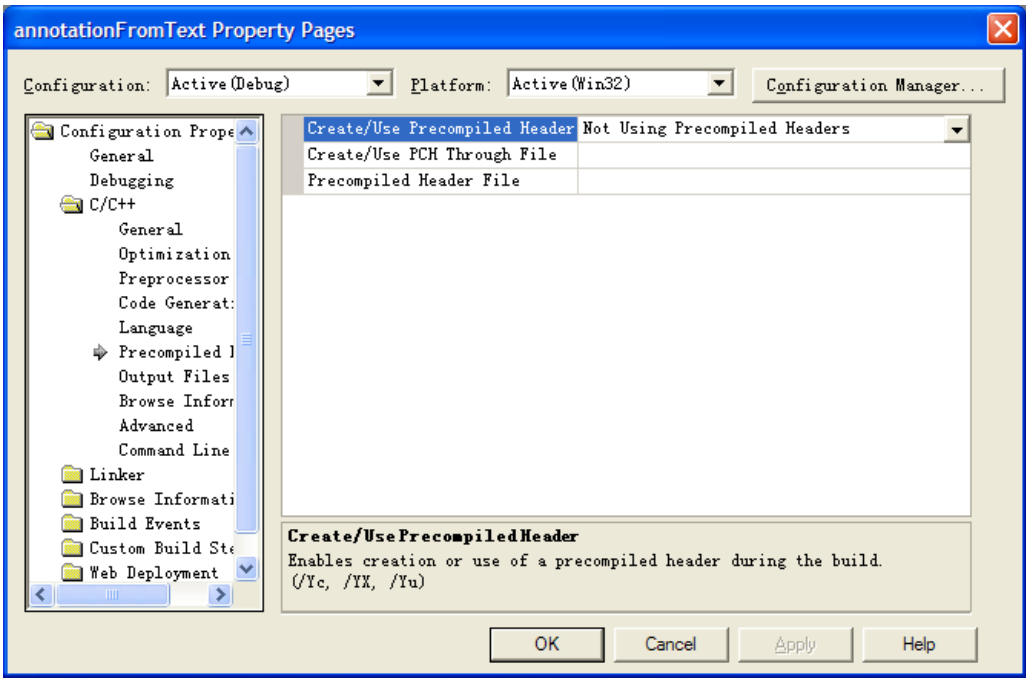
Configuration Properties->C/C++->Code Generation



Change the Stuct Member Alignment to the following:

```
Struct Member Aligment:
Default
```

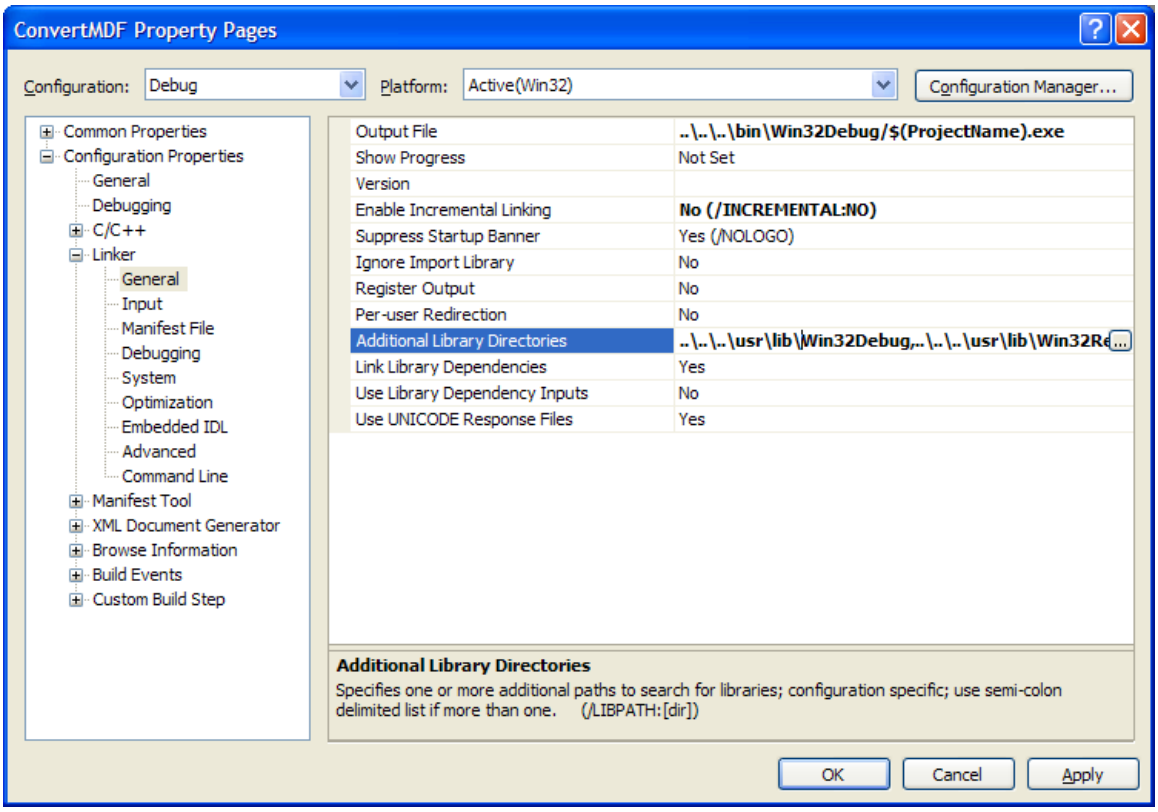
Configuration Properties->C/C++->Precompiled Headers



Change the Create/Use Precompiled Header to the following:

```
Create/Use Precompiled header:
Not using Precompiled Header
```

Configuration Properties->Linker->General



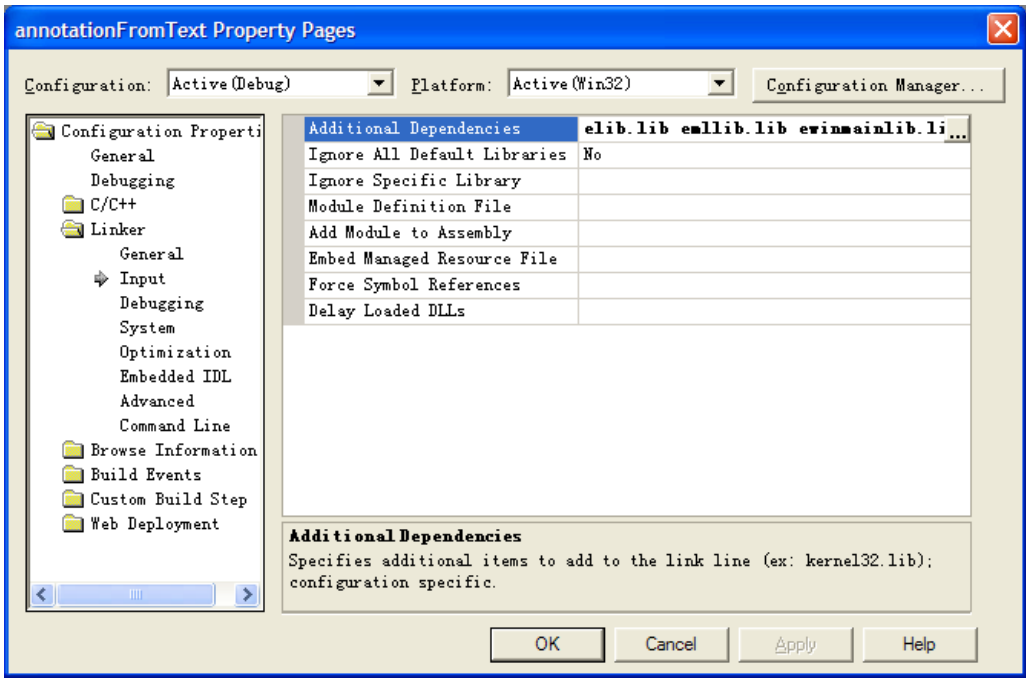
Change the Output file to the following:

```
Output File:
.\..\..\bin\Win32Debug/$(InputName).exe
```

Change the Additional Library Directories to the following:

```
Additional Library Directories:
.\..\..\usr\lib\Win32Debug,.\..\..\usr\lib\Win32Release
```

Configuration Properties->Linker->Input



Change the Additional Dependencies to the following:

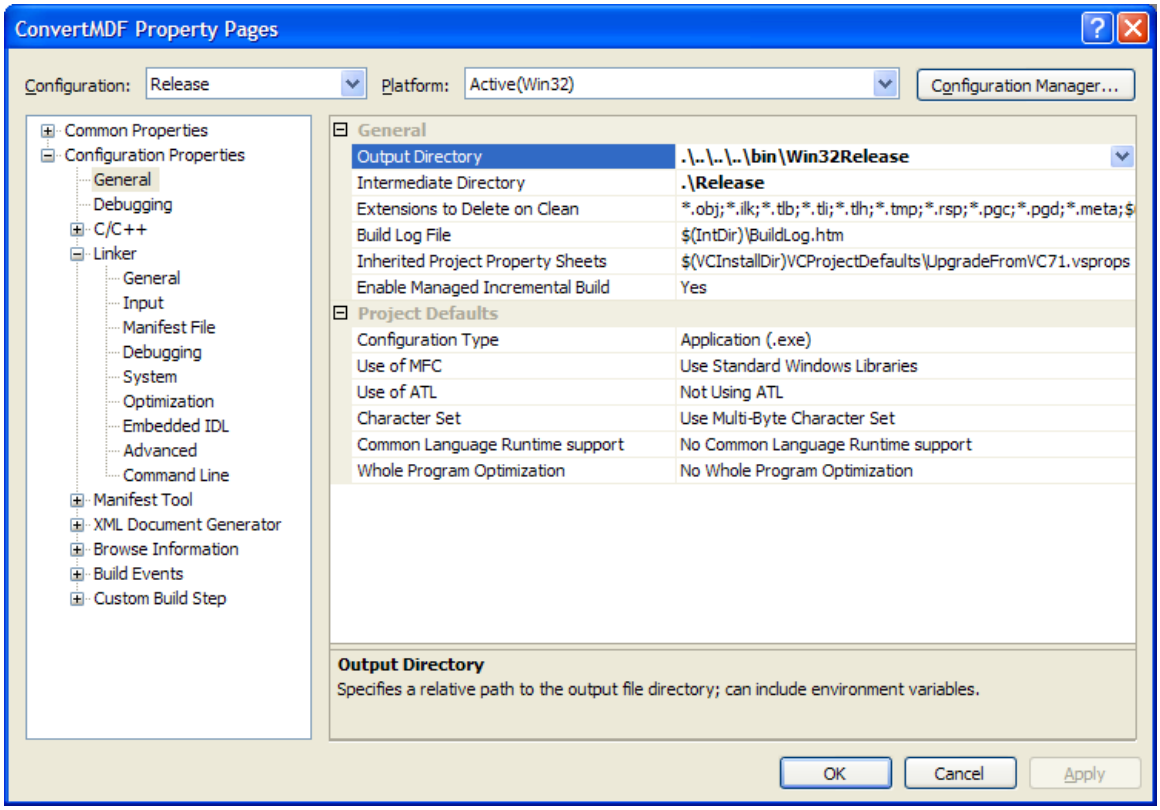
```
Additional Dependencies:
      emllib.lib
      ewinmainlib.lib
      elib.lib
      eraster.lib
```

Note: *You should also include the "**viewlib.lib**" if you want to use **edis_*()** function.*

Release version

Many of the property settings, in the Release version, are the same as those found in the Debug version for Microsoft Visual Studio 2008. There are however some different property settings. They are listed below::

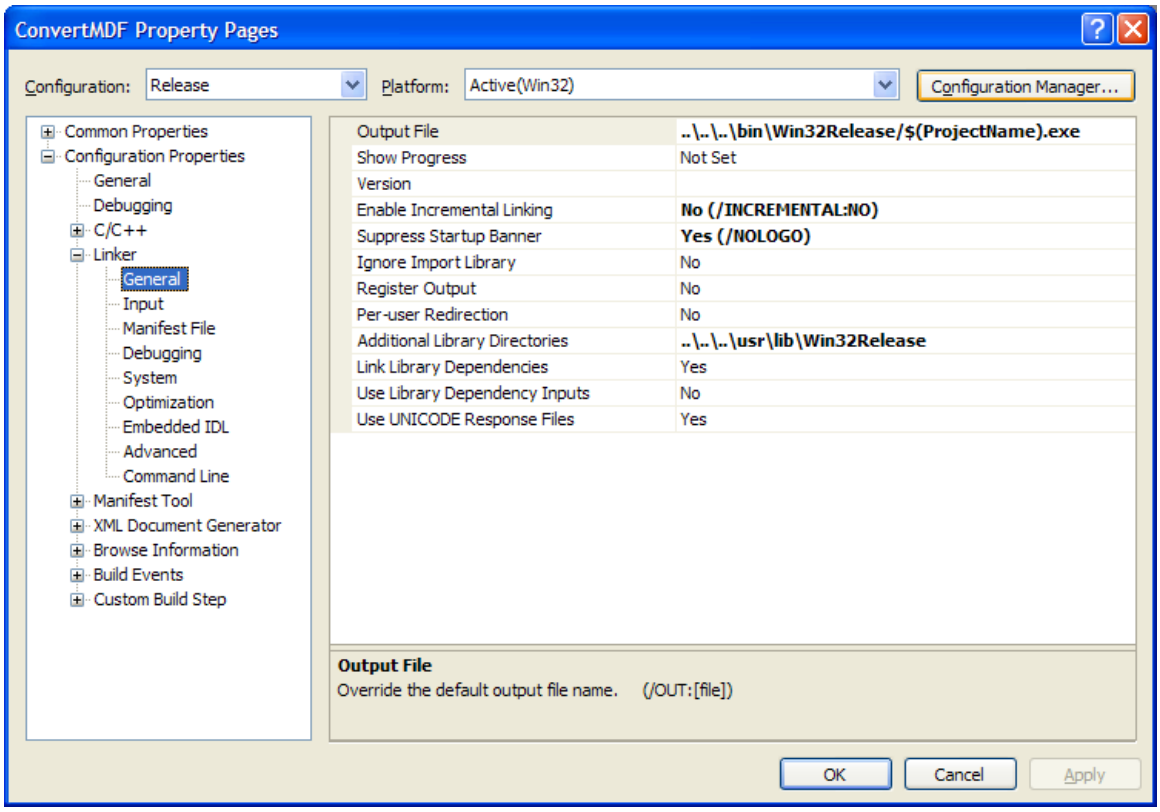
Configuration Properties->General



Change the output directory to the following:

```
Output Directory:
.\..\..\bin\Win32Release
```

Configuration Properties->Linker->General



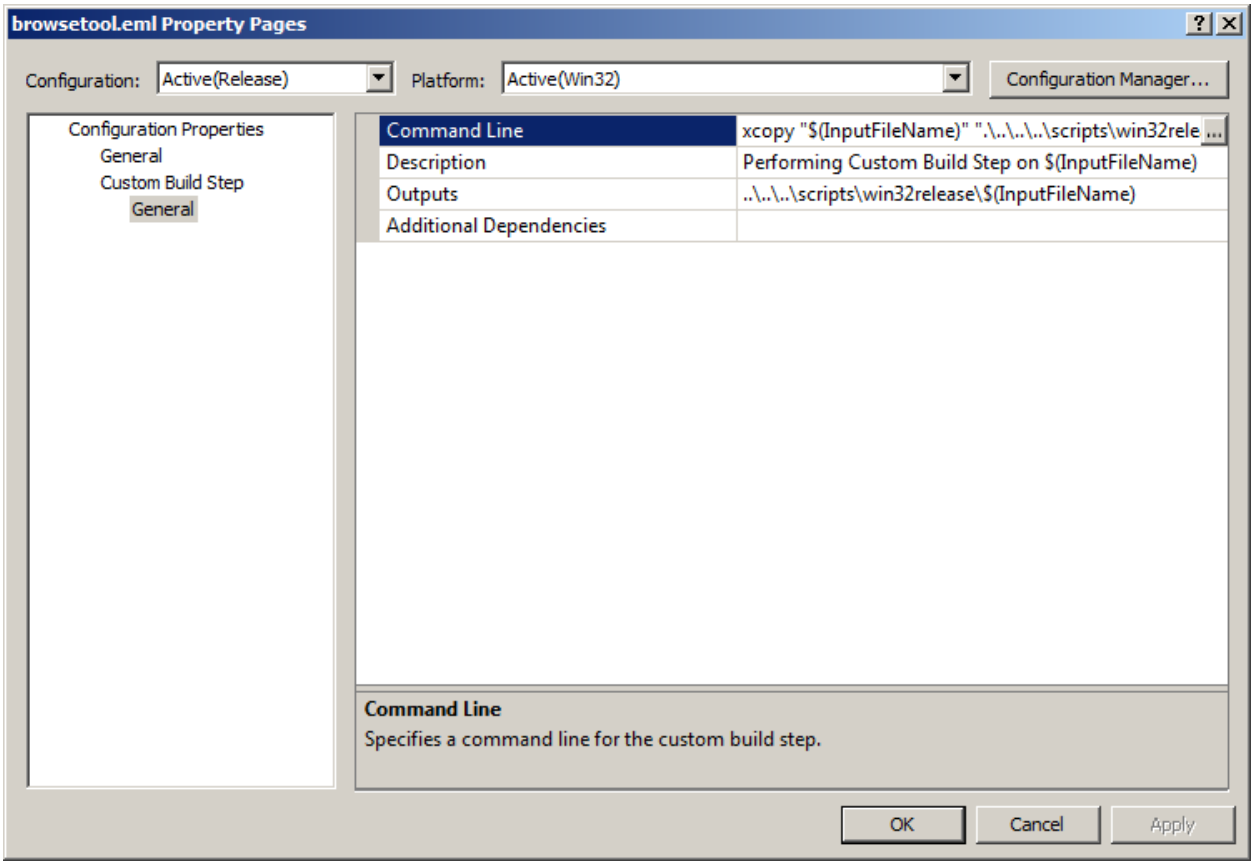
Change the output file to the following:

```
Output File:
.\..\..\bin\Win32Release/$(InputName).exe
```

Compile EML

Custom Build Steps for EML Scripts

The build steps just copy the eml script into **<IMAGINE_HOME>\scripts\Win32Release** folder.



Change the following settings:

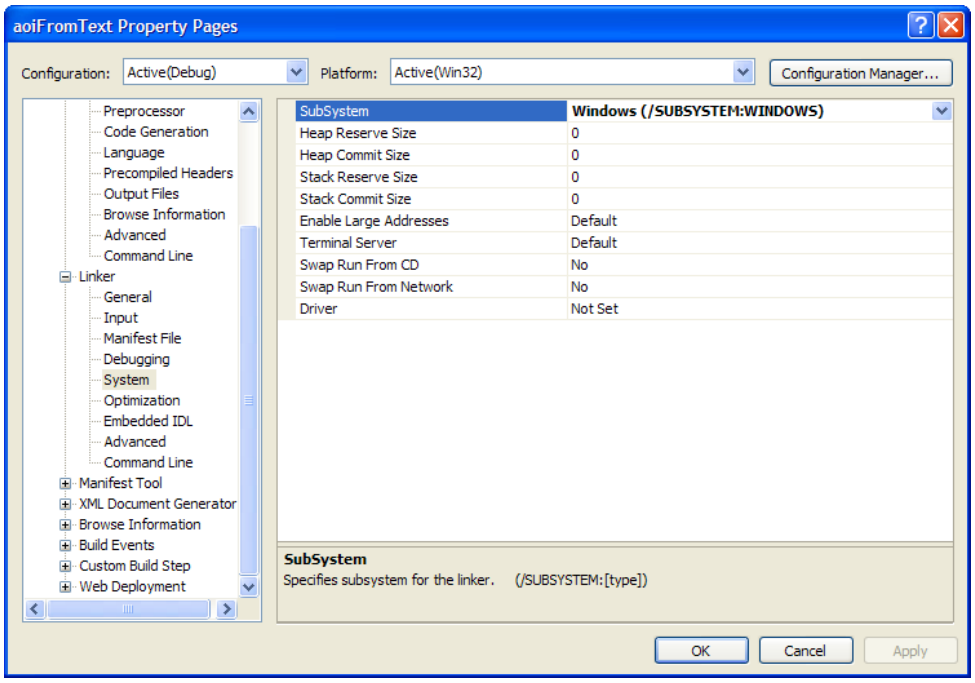
```
Command line:
      xcopy "$(InputFileName)" ".\..\..\scripts\Win32Release" /y /r /d /f

Description:
      Performing Custom Build Step on $(InputFileName)

Outputs:
      .\..\..\scripts\Win32Release\$(InputFileName)
```

ewinmainlib.lib

The Toolkit program (JOB & application) is a Windows32 program, not a console program. Win32 programs require **WinMain()** as the startup point, the **ewinmainlib.lib** actually will call **main()** internally. That is why there is only **main()** in the toolkit program and not **WinMain()**.

You can still create a console program for toolkit, but you may find that the standard I/O (e.g., **printf**, **scanf**) does not work. The reason is, the **eint_InitToolkit()** already redirects the standard I/O to pipe I/O.

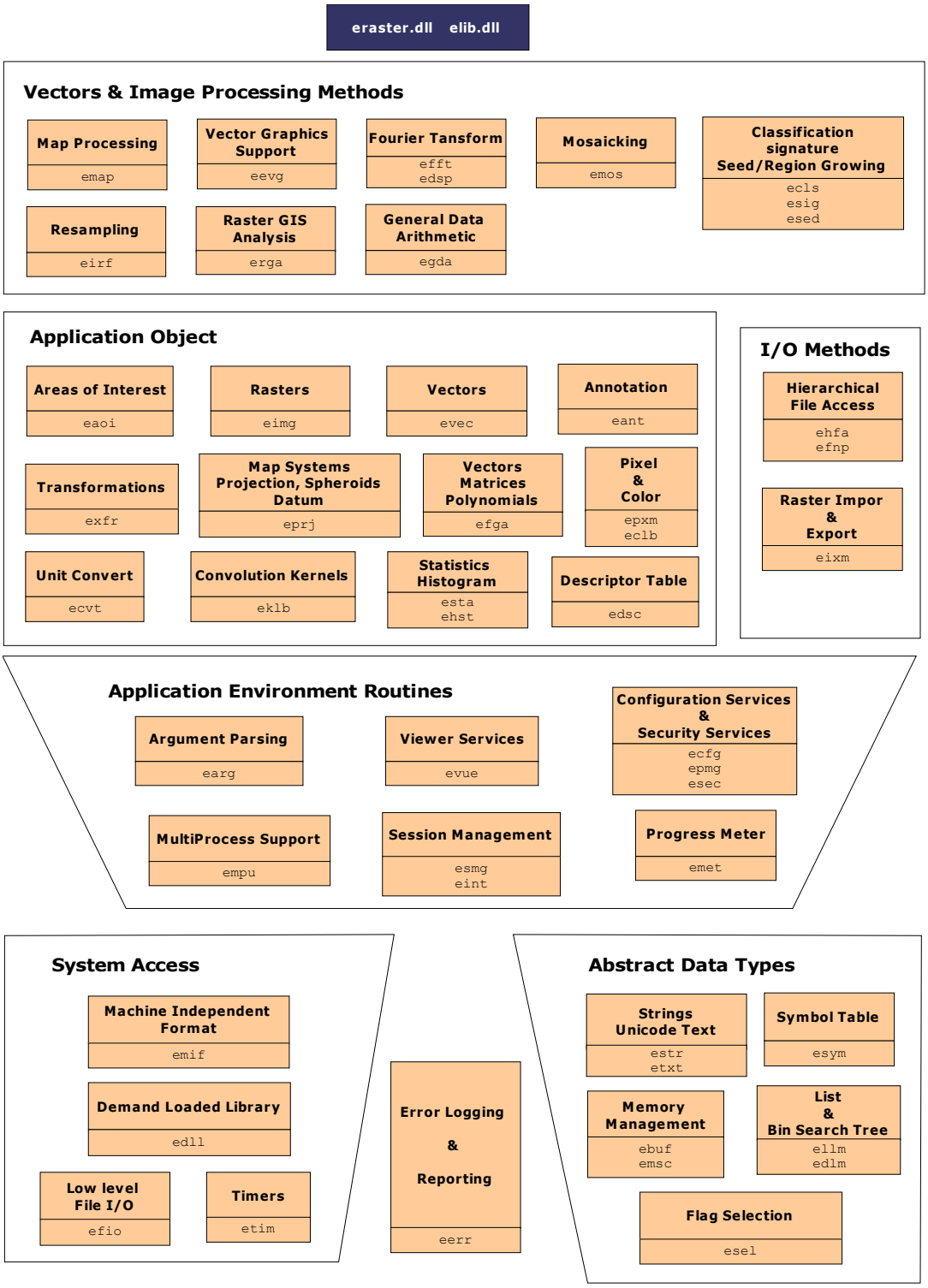
The following figure shows the SubSystem property in Microsoft Visual Studio:



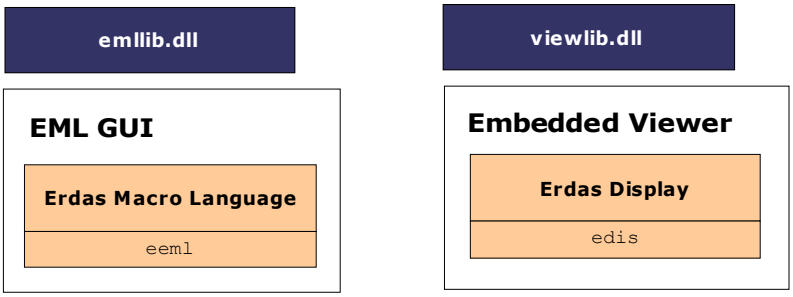
Toolkit Libraries Overview

There are four IMAGINE libraries of major interest to Toolkit application developers: **eraster.dll**, **elib.dll**, **emllib.dll**, **viewlib.dll**. Although they were mentioned earlier in the Microsoft Visual Studio Project settings section they will be looked at in more detail here.

The core is the base library, called **eraster** (ERDAS Raster Library). It contains all of the core functionality needed to create/read/write geospatial imagery. Layered on top of this is **elib** (ERDAS Library), which contains all of the non-GUI components of application creation such as session management, annotation I/O and a number of utility packages.


eraster.dll elib.dll
Vectors & Image Processing Methods
Map Processing
emap
Vector Graphics Support
eevg
Fourier Tansform
efft
edsp
Mosaicking
emos
Classification signature Seed/Region Growing
ecls
esig
esed
Resampling
eirf
Raster GIS Analysis
erga
General Data Arithmetic
egda
Application Object
Areas of Interest
eaoi
Rasters
eimg
Vectors
evec
Annotation
eant
Transformations
exfr
Map Systems Projection, Spheroids Datum
eprj
Vectors Matrices Polynomials
efga
Pixel & Color
epxm
eclb
Unit Convert
ecvt
Convolution Kernels
eklb
Statistics Histogram
esta
ehst
Descriptor Table
edsc
I/O Methods
Hierarchical File Access
ehfa
efnp
Raster Impor & Export
eixm
Application Environment Routines
Argument Parsing
earg
Viewer Services
evue
Configuration Services & Security Services
ecfg
epmg
esec
MultiProcess Support
empu
Session Management
esmg
eint
Progress Meter
emet
System Access
Machine Independent Format
emif
Demand Loaded Library
edll
Low level File I/O
efio
Timers
etim
Error Logging & Reporting
eerr
Abstract Data Types
Strings Unicode Text
estr
etxt
Symbol Table
esym
Memory Management
ebuf
emsc
List & Bin Search Tree
ellm
edlm
Flag Selection
esel

Layered on top of the **elib** library is the user interface library, called **emllib** (ERDAS Macro Language Library), which contains all of the functions for creating a portable GUI and interfacing with EML.



IMAGINE Toolkit Libraries Reference

Here is a brief introduction of IMAGINE C Toolkit Packages:

Error Logging and Reporting

Error Logging and Reporting

The Error Logging and reporting (**eerr**) package provides functions to create, delete, and print error reports. Nearly every function in the libraries of the IMAGINE Developers' Toolkit requires an argument that represents a place for the function to pass back an error report to the calling function. The functions and macros defined in this package will allow the programmer to work within the error reporting system of the IMAGINE Developers' Toolkit.

Low-Level File I/O and System Access Routines

Low Level File I/O

The Low Level File I/O (**efio**) package provides functions for creating, reading, writing, locating, and finding information about files and directories. Many of these functions are simply wrappers for existing POSIX and ANSI C functions. The wrapper allows for expansion of environment variables in file names and directory paths, as well as the translation of the standard 'errno' variable into an error report consistent with the eerr package. Other functions allow temporary file names to be generated and for a directory path to be searched while attempting to locate a particular file. The package also allows efficient I/O that is portable across platforms.

Machine Independent Format

The Machine Independent Format (**emif**) package allows data to be read and written to disk in a format that is sharable across compilers, operating systems, and machine architectures. The package allows a programmer to create and destroy dictionaries of object designs, create and destroy object designs in those data dictionaries, and to read and write data to disk based on an object design. The standard ERDAS IMAGINE data objects (layers, map information, descriptor tables, etc.) can be accessed through higher-level packages (eimg, edsc, etc.), so these functions are normally used to manipulate application-specific data objects within EHFA files.

Demand Loaded Library

The ERDAS Demand Loaded Library (**edll**) package contains functions for manipulating DLLs in an operating system-independent manner.
A demand loaded library is a shared library that is designed to be explicitly loaded and used by an application at run-time. The application typically makes use of the DLL by calling functions in the DLL through function pointers that the application locates using functions in this package.

Timer

The Timer (**etim**) package provides routines for timing code execution.

Application Environment Routines

Argument Parsing

The Argument Parsing (**earg**) package provides a convenient means of creating applications that are controlled by command line options. Parsing the command line and looking for options is a tedious task and without a set of standard tools the resulting command line syntax will vary from program to program.

Configuration Management

The Configuration Management (**ecfg**) package provides facilities for managing ERDAS IMAGINE's configuration database. The configuration database stores information about system resources such as tape drives, CD-ROM drives, printers and hosts to which an ERDAS IMAGINE session will require access. Initialization of the database is handled transparently to the application program when it is running in an ERDAS IMAGINE session (see esmg, eeml packages). Applications will be most interested in the functions of this package that query the configuration database for the values of preferences for configured devices.

Master Initialization

The Master Initialization (**eint**) package allows the programmer to initialize the IMAGINE Developers' Toolkit. This step is required in an application before the other IMAGINE Developers' Toolkit functions can be used.

Progress Meter Support

The Progress Meter Support (**emet**) package allows an ERDAS IMAGINE application to report its progress in an extensible way. Placing calls to the emet package at critical points in a process allows a user to track the progress of an application.

Preference Database

The Preference Database (**epmg**) package provides a programmer with an interface to the Preference Database. It provides functions to access, set, and change the preferences for different categories at global and user levels. It also provides callback mechanisms to notify the clients when a preference value is changed.

Session Manager

The esmg (Session Manager) package provides an interface to the ERDAS IMAGINE Session Manager. The primary functions are: connect to the Session Manager, indicate job state, indicate job progress, log warning/status messages in the Session Log, and indicate the end of a job.

Viewer

The Viewer (**evue**) package contains a set of functions for interaction with the ERDAS IMAGINE Viewer. These functions allow an application to do the following:
- Query the contents of specified Viewers.
- Load image, annotation, vector, or AOI layers into specified Viewers.
- Add callbacks on images in the Viewer.
- Create graphics representing lines or areas at specified locations.
- Interactively select areas or lines.
- Display compositions.
- Set image extents.
- Create/destroy Viewers.
- Warp images.
- Create screen links.
- Set convolution kernels.

Abstract Object Manipulation Routines

Binary Search Tree

The Binary Search Tree (**ebst**) package provides a complete set of tools for creating and maintaining sorted binary search trees. Modeled after the qsort/bsearch functions in the standard C libraries, the ebst package works with any type of programmer-supplied data for which the programmer provides a compare function.

Dynamic List Manager

The Dynamic List Manager (**edlm**) package provides a means to create and retrieve data from lists and stacks of arbitrary size. The lists or stacks may contain any type of object. Lists and stacks are useful in situations in which you need to build a set of data by sequentially adding objects, but you do not know beforehand how many objects will be in the set.

Linked List

The Linked List (**ellm**) package provides a common set of functions used to create and manage linked lists. The lists may contain any type of data.

Miscellaneous

The Miscellaneous (**emsc**) package defines macros and functions that deal with memory management or are otherwise not specific to any one routine in the IMAGINE Developers' Toolkit (e.g., EMSC_MIN, EMSC_MAX, EMSC_CURRENT_VER).

Selection

The Selection package (**esel**) provides a means of keeping track of a large number flags for indicating which items in a set are selected. The selection is a collection of numbered flags. Each flag can be set, cleared or tested for state. There are convenience functions for setting and clearing all of the flags. Each flag (or entry) is identified by an integer index which begins at 0. In addition to the functions which simply manipulate the selection table, this package also provides the capability to create and evaluate boolean expressions which are used to make selections. This works by translating a string expression into an internal form called an Esel_Code which can be used to quickly evaluate the expression The esel_Code* functions provide this capability.

String Manipulation

The String Manipulation (**estr**) package currently provides functions for six categories of character string manipulation:
- General string manipulation (compare, change, duplicate, analyze character strings),
- File name string parsing,
- String list manipulation,
- String expression evaluation,
- Numeric formatting to a character string, and

- Miscellaneous string functions (e.g., converting errno to a string description of the error).

Symbol Table

The Symbol Table (**esym**) package provides a set of functions used to create and manage symbol tables. Each holds one or more symbols which relate a string with some type of user data. The package provides functions for adding symbols to the table and for locating symbols within a given table.

Unicode String Support

The Unicode String Support (**etxt**) package is designed to allow IMAGINE to work with UNICODE based strings and characters. Most of the package functions named similar to the corresponding ANSI functions and perform the same functionality but allow working with so-called wide characters and strings. Declaration of a UNICODE string or character is also similar to a declaration of standard ANSI C string or character – just use **Etxt_Char** or **Etxt_Text** instead of **char** or **char***.

Application Object Manipulation Routines

Annotation

The Annotation (**eant**) package provides functions for creating, reading, writing, rendering, and editing ERDAS IMAGINE annotation elements and their styles. Annotation elements consist of polylines, polygons, ellipses, elliptical arcs, points, text and groups.

Area of Interest

The Area of Interest (**eaoi**) package provides basic tools for area of interest analysis. It includes AOI structure operations (create, delete, copy, etc.), AOI input and output operations, and AOI rendering operations.

Color Library

The Color Library (**eclb**) package provides support for color libraries, RGB/IHS conversions and level slicing.

Unit Conversion

The Unit Conversion (**ecvt**) package provides routines for converting between units of distance, area, time, volume, angle, etc. The units supported are defined in a database ("**units.dat**"), which defines the relation between a "standard" unit and others. For example, the standard distance is in meters, all other distance units are defined as multiples of meters.

Descriptor Table Access

The Descriptor Table Access (**edsc**) package provides basic tools for manipulating descriptor tables. A descriptor table is the part of an ERDAS IMAGINE . img file that stores ancillary information about a particular data value or set of data values in a raster layer. The information for each data value or set of data values might include a histogram value, color table look-up values, a class name, total area, etc. The edsc functions allow the programmer to easily create in-memory data structures for descriptor tables and to easily pass descriptor table information between memory and disk without having to deal with the lower level **ehfa**, **emif**, and **efio** packages.

Vectors, Matrices, Polynomials

The Floating-Point Graphics Arithmetic (**efga**) package provides routines for performing commonly used vector, matrix, point, and polynomial (including affine) transformation functions.

Hierarchical File Access

The Hierarchical File Access (**ehfa**) package provides an implementation of the ERDAS IMAGINE EHFA file format. This format maintains an object-oriented representation of data in a disk file through the use of a tree structure. All non-ASCII files used by ERDAS IMAGINE are in this format (e.g., .img, .ovr, etc.). The functions in this routine allow the programmer to identify, create, copy, open and close EHFA files; and locate, read and write objects within an EHFA file. The standard ERDAS IMAGINE data objects (layers, map information, descriptor tables, etc.) can be accessed through higher level packages (**eimg**, **edsc**, etc.), so these functions are normally used to manipulate application-specific data objects within EHFA files.

File Node Parse

The File Node Parse (**efnp**) package breaks up strings containing file names and ehfa node names and ranges of ehfa node names into their component parts. For example, it can be used to separate the path "**D:/data/lanier.img(:Layer_1)**" into the components "**D:\data**" "**lanier.img**" and "**(:Layer_1)**".

Histogram and Lookup Table

The Histogram and Lookup Table (**ehst**) package provides various functions on histograms and lookup tables, primarily in support of the histogram tools and the contrast adjustment in the Viewer. Histogram, LUT and breakpoint structures can be created, converted and edited using these routines.

Image File Access [RasterFormats DLL]

The Image File Access (**eimg**) package provides tools to access and manipulate data in image files supported by the RasterFormats DLL Class, including ERDAS IMAGINE .img files. The package includes functions to read and write objects commonly found in geospatial raster datasets such as map information, projection parameters, statistics, histograms, covariance matrices, descriptor tables, class names, and color values. The package also provides high-level

functions for processing the raster data within the dataset including functions to create, read, and write raster layers; associate windows and areas of interest with a raster layer; and apply neighborhood functions to raster layers. It is through this package and its constructs that an application may modify the actual data values in a raster layer.

Kernel Library

The Kernel Library (**eklb**) package provides for reading and writing convolution filter kernels from a kernel library file.

Map Projection

The Map Projection (**eprj**) package provides tools for storing and retrieving map projection information for a layer and for converting coordinates between map projections. It also contains functions necessary for developing projections that are external to the ERDAS IMAGINE package.

Pixel Management

The Pixel Management (**epxm**) package provides functions for creating and copying rectangular arrays of pixels of any of the thirteen data types supported by ERDAS IMAGINE. The pixel rectangles are compatible with the egda functions.

Statistics

The Statistics package (**esta**) provides tools for manipulating (i.e., reading and writing to/from files, creating and copying in-memory data structures, computing, etc.) statistics (mean, standard deviation, etc.), histograms, covariance matrices, color tables, and class names. This is a middle level package in that it is utilized by the eimg package but relies on the edsc, ehfa, and emif packages.

Vector

The Vector (**evec**) package provides tools for:
- Creating and deleting structures related to vector layers.
- Opening and closing vector layers.
- Reading features and their attributes.
- Getting descriptive information about the layer.
- Measuring distances and lengths.
- Modifying vertices of arcs (splining, generalizing, and densifying).
- Determining the spatial relationship between points, lines, and polygons.

Transform [GeometricModels DLL]

The Transform (**exfr**) package provides a generalized set of tools for creating and managing coordinate transforms, regardless of the type. Each transform may be a combination of any number of the basic transforms. The package provides functions for mapping arrays of points

through a transform, inverting transforms, and composing transforms. The package is also constructed so that the programmer can create new types of transforms. This package is extensible through the use of the Geometric Model DLLs.

Vectors & Image Processing Methods

Seed/Region Growing

The Seed/Region Growing (**esed**) package performs the region growing functions. Functions exist at different levels to do the raster region grow, convert the raster region to a polygon, and generate an annotation layer of the region polygon.

Signature Management

The Signature (**esig** and **esig_io**) packages contain all the signature support functions. Esig provides functions to create signatures, set and get signature attributes, copy signatures, manage lists of signatures, merge signatures, etc. Esig_io contains all the file I/O functions for signatures and signature lists.

Image Mosaicking

The Image Mosaicking (**emos**) Package provides basic tools for the Image Mosaicking.

Feature Space

The Feature Space (**efsp**) package contains all the feature space functions. These include the reading and writing of feature space nodes as children in . img files and as lists of feature space nodes for communication with the transformation process. The functions in this package will also convert the image data into feature space plots and map auxiliary files (thematic) into the feature space.

Digital Signal Processing

The Digital Signal Processing (**edsp**) package provides functions that perform one- and two-dimensional forward and inverse Fast Fourier Transformations (FFTs) on complex or real data. Most functions in this routine have been specially designed for efficient transformation of real-valued sequences and arrays. These sequences have certain symmetries that reduce both storage requirements and the number of computations. The length of each sequence must be a power of two.

Fast Fourier Transform

The Fast Fourier Transform (**efft**) package provides “high-level” two-dimensional faster Fourier transforms.

Image Resampling [ResampleMethods DLL]

The Image Resampling (**eirf**) package provides tools to resample imagery that is being geometrically transformed (see Transform). Three resampling methods are supported: nearest neighbor, bilinear interpolation, and cubic convolution. It is possible to support other types of resampling through the ResampleMethods DLL Class mechanism.

Map Printing

The Map Printing (**emap**) package provides routines for generating and reading map files (.map) and for creating, reading and writing all types of files associated with hardcopy map output.

Raster GIS Analysis

The Raster GIS Analysis (**erga**) package provides tools to analyze raster data. It includes tools for point analysis, neighborhood analysis, regional analysis, and feature extraction. This package is a high-level package that operates on top of the eimg package (unlike the egda, efga, and eirf packages which are not strictly dependent on any eimg constructs).

General Data Arithmetic

The General Data Arithmetic (**egda**) package provides basic tools to perform operations on various data objects based on the Egda_BaseData structure. Objects based on this data structure are prevalent in the IMAGINE Developers’ Toolkit libraries (e.g., the eimg_PixelRect). The derivatives of this data structure include layer stack, matrix, table, vector, window, and scalar objects. In addition to providing functions that create, copy, modify, and destroy these data types, the routines also handle operations such as data type conversion, standard point functions (e.g., sin, cos, etc.), GIS point functions (e.g., diversity or density), single argument operations (e.g., not or sign), multiple argument operations (e.g., multiply or divide), and neighborhood functions (e.g., majority or convolve).

Graphics Support

The Graphics Support (**eevg**) package provides functions for rendering vector-type data (annotation, vectors) to output devices. It handles the rendering of line styles, polygon fill styles and smooth outline scalable text.

EML GUI Access Routines

The EML (**eeml**) package provides a programmer with an interface to all the ERDAS Macro Language (EML) API functions. Application programs that present a GUI through an EML script should use the functions in this package. The APIs in this package will provide functions to do the following:

- Create a GUI for the application program using the EML scripts as templates,
- Display/undisplay the dialog frames defined in the EML script,
- Add/remove callback functions on the GUI parts defined in the EML script,
- Manipulate GUI objects (get/set values etc.).

Button

The Button (**eeml_button**) package provides functions specific to the EML button part. The APIs in this package will provide functions to

* Get/set colors for color buttons
* Arm/disarm/toggle buttons

Canvas

The Canvas (**eeml_canvas**) package provides a system-independent interface to on-screen and off-screen graphics primitives. Many of the primitives are specifically designed to work with the structures from the eimg package, making it easier to read ERDAS IMAGINE files and display the data to the screen. These primitives can be used to build graphic applications such as the ERDAS IMAGINE Viewer. Using this package in conjunction with the rest of the EML package will result in an application that is easily ported between the various operating systems and window systems that ERDAS IMAGINE supports.

Dialog

The Dialog (**eeml_dialog**) package contains functions that provide consistent interaction with the user for common user-interface operations such as asking the user for confirmation, displaying a warning message, displaying a status message, etc.

Frame

The Frame (**eeml_frame**) package provides functions specific to EML dialog frames. The APIs in this routine provide functions to

- set/get geometry to/from displayed or undisplayed frames
- display the frame on a different screen (dual-headed systems)
- set the title string, display the status message, show/hide the menu bar, show/hide the status bar, etc. access frame menus, etc.

Generic Part

The Generic Part (**eeml_generic**) package provides functions specific to the EML generic part. The generic part is designed as a space holder in an EML dialog. It typically reserves space in the dialog for a user interface part that cannot be specified in EML, such as a CellArray or a canvas. Aspects of the user interface that cannot be handled in EML must be handled programmatically. Through the eeml_generic portion of the eeml package, functions are made available to the programmer that provide a consistent and portable way to display a busy cursor over a generic part while that part is being updated.

Menu

The Menu (**eeml_Menu**) package provides the functions to create and interact with popup and pull down menu systems.

Popup List

The Popup List (**eeml_popuplist**) package provides functions specific to the EML popup list part. The APIs in this package will provide functions to
- replace the old list with a new list
- replace the old picture list with new picture list

Projection Editor

The Projection Editor (**eeml_prjeditor**) package provides a function to control an interactive Projection Editor that can be used by application programs to get projection parameters from the user.

Scrolled List

The Scrolled List (**eeml_scrollist**) package contains functions specific to the EML scroll list part. The functions allow application programs to manipulate the EML scroll list (e.g., add items, replace items, etc.).

Tablet Digitizer

The Tablet Digitizer (**eeml_tablet**) package provides functions to access the Tablet Digitizer driver via an interactive GUI. The routine provides API functions to do the following:
- open/connect to the tablet digitizer
- add callbacks on the digitizer
- close/disconnect from the tablet digitizer

Text

The Text (**eeml_text**) package contains functions specific to the EML text part. The functions will allow application programs to:
- insert text
- overwrite/replace/append text
- turn on/off the highlight attribute of the text
- get/set the cursor position on the text
- cut/copy/paste text
- set/get/clear the primary selection on the text

CellArray™

The CellArray ™ (**eeui_CA**) package provides a single user interface for dealing with the management of tabular data. The programmer provides the description of the columns (string, double, color, etc) and provides the functions to get and put the data. The CellArray package manages the navigation and display of any amount of data. Built-in functions allow search, sorting, and report generation.

Charts

The Chart (**eeml_Chart**) package provides a graphical part, which can be used to plot data in several modes. The chart is a tool that can plot tabular data as line graphs on a grid with an associated legend. This is the basis of the various profile tools in ERDAS IMAGINE.

ColorWheel

The Colorwheel (**eeui_CW**) package provides an IHS color part that can be used for color selection. A slider controls the Intensity, with Hue and Saturation mapped to the angle around a circle and the distance from its center. To select colors, the user can drag a single point within the color wheel. The application is notified of color changes through a callback mechanism.

Histogram

The Histogram (**eeui_Histogram**) package provides an interactive tool for displaying and manipulating histogram data. The user may zoom in to get more detail on any area of the histogram. In addition, the routine provides functions for controlling the contents of the plot as well as printing the histogram to a PostScript file.

2D Visualization Routines

The Viewer (**edis**) package provides a basic set of tools for embedding one or more Viewers into an IMAGINE application. A Viewer can display various types of 2D data including vectors, annotation, and images. These routines also provide a means of extending the types of data that can be displayed within the Viewer via the ViewLayer Class.

ViewWindow

The ViewWindow (**Edis_ViewWindow**) package is responsible for managing the display area of the Viewer. When a Viewer is created a handle to the Edis_ViewWindow is returned and can be used with subsequent calls to the Edis_ViewWindow API. This API can be used for toggling scroll bars, adding ViewLayers, scrolling imagery, etc.

ViewLayer

The ViewLayer (**Edis_Viewlayer**) package that can be used for manipulating ViewLayer objects within a ViewWindow. This API is used for closing ViewLayers, changing band combinations, setting zoom levels, etc. The API can be used with existing ViewLayer types such as the TrueColor, PseudoColor, GrayScale, Annotation, Vector, and AOI layers.

ViewLayer Class

The ViewLayer (**Edis_ViewLayer**) Class defines the mechanism used for creating new types of ViewLayers that can be displayed within a ViewWindow. This becomes necessary when the

ViewLayer types that are provided with the toolkit do not provide features required by the application.

Graphics Context/Target

The Graphics Context and Graphics Target API provide ViewLayers the mechanism needed to render them into the ViewWindow. When implementing new ViewLayer types using the Edis_ViewLayer Class it will be necessary to utilize these functions. The Graphics Context is provided for setting attributes such as color, size, etc and the Graphics Target is provided for doing the actual drawing.

Selector

The Selectors (**Edis_SelNew**) package provides an interface for creating graphical representations of objects that are used by the user for editing elements. The selectors do not provide a very robust set of display styles because they are typically used for displaying fast graphical elements including polylines, polygons, points, icons, and rectangles.

Selector Class

The selectors class provides a mechanism for new selector types to be created when the existing selectors do not provide the features required by the application.

Picks

The Picks API provides tools used when the user is responsible for creating an element interactively using the mouse. The picks have been used for creating annotation elements, AOI elements, selecting Viewers, etc. The API returns the coordinates selected by the user to the caller.

Raster Edit

This API provides a few routines for modifying properties of raster images including contrast and convolutions kernels. These functions can also be used for modifying the pixel values in a TrueColor or GrayScale image layer.

Class Notes:

Section 5: Creating JOBs using the Toolkit

Section objective:

In this section you will learn how to create JOBs using the Toolkit. The first 3 exercises deal with basic Toolkit concepts and introduces the EIMG package which allows you to read pixel values and write them into an IMAGINE native format (***.img**).

The remaining exercises will instruct you on how to convert a known data format (***.mdf**) into an IMAGINE native format (***.img**). It will also introduce the concepts of map and projection information and instruct you on how to add this information to an image.

Packages used:

eint
earg
emet
eimg
efio
eprj
eerr
egda
emsc
estr
exfr

Exercise 1: "Hello World" Toolkit Program

Exercise Objective:

The following code is a hello world program for IMAGINE Toolkit, it will initialize the Toolkit global variables (flags) and display a dialog box.

Packages used:

eint
eerr
emsc
esmg

Code Snippet (Sec5_01): helloworld.c

```
/*****************************************************************************
**
**    HELLO WORLD
**    This is "Hello World" progam for IMAGINE C Toolkit, it will initialize the
**    Toolkit global flags and display a dialog box
**
*****************************************************************************/

#include <eerr.h> // ERROR LOGGING AND REPORTING PACKAGE
#include <eint.h> // TOOLKIT INITIALIZATION PACKAGE.
#include <esmg.h> // SESSION MANAGER API PACKAGE
#include <emsc.h> // MISCELLANEOUS FUNCTIONS FOR COMMON OPERATIONS

/*
** ERROR CHECKING MACROS
*/
#define EFS0( msg ) EERR_FATAL_SET_0( __LINE__, msg )
#define EFS1( msg, arg ) EERR_FATAL_SET_1( __LINE__, msg, arg )


int main(int argc, char **argv)
{
      Eint_InitToolkitData *tkInit = NULL;

      /*
      ** DECLARES AND INITIALIZES ALL VARIABLES TO BE USED BY THE OTHER EERR MACROS.
      */
      EERR_INIT("Hello World", &lclerr, lclerr);

      /*
      ** INIT TOOLKIT
      */
      tkInit = eint_InitToolkit( (Emsc_Opaque**)&lclerr );
      EERR_CHECK(lclerr, EFS0("ERROR eint_InitToolkit"));

      /*WEDS
      ** DISPLAY MESSAGE
      */
      esmg_LogMessage( ESMG_LOG_TERSE, &lclerr, "Hello World!", NULL );
      EERR_CHECK(lclerr, EFS0("ERROR esmg_LogMessage"));


cleanup:

      EERR_SHOW(lclerr, EERR_DEBUG);
      return 0;
}
```

Code Explanation:

Toolkit Initialization

You should always start with the **eint_InitToollkit()** function call to setup IMAGINE Toolkit. This function appears in every Toolkit program.

---

eint_InitToolkit()

The prototype of this API is:

```
Eint_InitToolkitData * eint_InitToolkit(errorin)
```

This function allocates and initializes ERDAS Toolkit Initialization flags (a global structure containing initialization information for core toolkit packages), it returns the initialization result (a pointer to that global structure).

This API will not actually initialize all the Toolkit packages, it will only initializes the **ehfa** and **esta** packages (these 2 packages are often used by all other packages). The **ehfa** package is the ERDAS Hierarchical File Access Package, and the **esta** package is the ERDAS statistics package.

If you want to use APIs from other packages, you will have to initialize them individually before using them. e.g. **eant_init()** is used to initialize the **eant** package, and **eeml_init()** is used to initialize the **eeml** package.

Toolkit Error Tracking Mechanism

Most Toolkit functions contain an error tracking argument. A problem exists if a non-NULL error pointer is returned. When this happens a function, detecting an error, creates an **Eerr_ErrorReport** structure that contains;

- The name of the function in which the error occurred
- An integer error code
- The severity (fatal or warning)
- Text describing the error
- A pointer to another **Eerr_ErrorReport** structure

You will find that there are a number of macros available to automate the process of creating an error report and returning it to the Session Manager.

The **EERR** macros are intended to make the process of error checking and reporting easier. Used appropriately, they can reduce the amount of error reporting code that is visible in any given function thereby making the real logic of the function easier to read.

The macros rely on the concept of a returned error pointer-pointer and a local error pointer. When working with the ERDAS Error Reporting package, a programmer finds that it is usually handy to make

function calls using a local error pointer and then set a passed in error pointer if the local error pointer is set by the called function. This arises from the fact that once an error occurs, in many cases, cleanup needs to be performed. This cleanup must be performed by calling additional functions which take their own error arguments. Any errors that occur during cleanup must be handled in their own way, whether it is to display them immediately, or completely ignore them. In either case, it is usually not desirable to include the cleanup errors in the error report being passed back to the calling function.

EERR_INIT()

The prototype of this API is:

```
EERR_INIT( functionName, placeToReturnErrorPointer, localErrorPointer )
```

The **EERR_INIT** macro serves as a declarator and initializer of all variables that will be used by the other **EERR** macros in the error reporting for a function. This macro must only be used in the declaration list of a compound statement (block).

The **functionName** parameter is the string literal representing the function name.

The **localErrorPointer** is the name that will be used as a local error pointer in the function.

A variable with the name **localErrorPointer** of type (**Eerr_ErrorReport ***) will be declared by the **EERR_INIT** macro in the block within which it is included.

The **placeToReturnErrorPointer** parameter is the name of the formal argument of the function through which any error reports will be passed back to a calling function. This parameter is required to be of type (**Eerr_ErrorReport ****) to follow the ERDAS Toolkit error reporting conventions. If there is no formal argument of the function through which an error report will be passed back to the calling function (such as in a "**main**" function or a callback), then the **placeToReturnErrorPointer** may be specified as (**& localErrorPointer**). In these types of functions, the **EERR_SHOW**[_<**ArgCount**>] type macros should be used to display and free the errors or the errors can be explicitly ignored with the use of the **EERR_DELETE** macro.

EERR_CHECK()

The prototype of this API is:

```
EERR_CHECK( cond, code )
```

If **EERR_CHECK** macro checks to see if **cond** holds and if it does, **code** will be executed. **cond** is often a check to see if the local error report pointer that was declared with the **EERR_INIT** macro is not **NULL**. After **code** is executed an unconditional branch to a label named "**cleanup**" will be taken.

EERR_SHOW()

The prototype of this API is:

```
EERR_SHOW( ept, mode )
```

If **ept** is not NULL, the **EERR_SHOW** macro will print the error report with an **Eerr_ErrorReportingMode** of mode, and free the error report in ept, and set ept to NULL.

The **Eerr_ErrorReportingMode** structure is defined as:

```
typedef enum {
    EERR_DEBUG,     /* tailor error reporting for a programmer */
    EERR_ENDUSER    /* tailor error reporting for end user */
} Eerr_ErrorReportingMode;
```

EERR_FATAL_SET_<n>()

The prototype of this API is:

```
EERR_FATAL_SET_<n> ( code, msg, [ arg0, arg1, ..., argn ] )
```

The **EERR_FATAL_SET_<n>** macros creates an **Eerr_ErrorReport** with an **Eerr_ErrorClass** of **EERR_FATALERROR**, an **Eerr_ErrorCode** of **code**, and a message of **msg** to the **localErrorPointer** set up by the **EERR_INIT** macro and assign it to the ***placeToReturnErrorPointer** pointer set up by **EERR_INIT**. If **localErrorPointer** is not the same as ***placeToReturnErrorPointer**, **localErrorPointer** is then set to NULL.

Macros are defined for n values of 0 through n argument for **msg** must be supplied in the macro call.

EERR_WARNING_SET_<n>()

The prototype of this API is:

```
EERR_WARNING_SET_<n> ( code, msg, [ arg0, arg1, ..., argn ] )
```

The **EERR_WARNING_SET_<n>** macros are similar to the **EERR_FATAL_SET_<n>** macros; it will create an **Eerr_ErrorReport** with a **Eerr_ErrorClass** of **EERR_WARNING**.

EERR_DELETE()

The prototype of this API is:

```
EERR_DELETE( ept )
```

The **EERR_DELETE** macro simply deletes the error report pointed by **ept** and sets **ept** to NULL.

Toolkit API naming rule

Aside from the basic C code, we have several different types of Toolkit entities, all of which start with "**e**" or "**E**". The remaining three letters designate the package.

Each package contains at least one "***.h**" file; a few contain more than one; Most package functions are in the form of "**packagename + object + action**"; e.g. **eimg_LayerRead**.

Here is how to recognize what is what:

Type	Case	Example
Functions	All lowercase.	**eint_*** **earg_*** **eimg_*** **eerr_*** **emsc_***
Data Types and Symbols	Data Type, Structures and enumerations always begin with a capital E	**Eint_*** **Earg_*** **Eimg_*** **Eerr_***
MACROS	All uppercase.	**EERR_SHOW** **EIMG_LAYER_OPTION_READONLY**

Class Notes:

Exercise 2: A Template for a Toolkit JOB

Exercise Objective:

In this exercise, we will create a template for a Toolkit JOB. You will be able to modify this template for future exercises.

Packages used:

eint
eerr
emsc
esmg

Code Snippet (Sec5_02): jobtemplate.c

```
/*****************************************************************************
**
**    JOB TEMPLATE
**    A template for Toolkit JOB
**
*****************************************************************************/

/*
** TOOLKIT INCLUDES
*/
#include <eerr.h> // ERROR LOGGING AND REPORTING PACKAGE.
#include <eint.h> // TOOLKIT INITIALIZATION PACKAGE.
#include <esmg.h> // SESSION MANAGER API PACKAGE.
#include <emsc.h> // MISCELLANEOUS FUNCTIONS FOR COMMON OPERATIONS.
#include <earg.h> // ARGUMENT PARSING PACKAGE.
#include <estr.h> // STRING PACKAGE.


/*
** ERROR CHECKING MACROS.
*/
#define EFS0( msg ) EERR_FATAL_SET_0( __LINE__, msg )
#define EFS1( msg, arg ) EERR_FATAL_SET_1( __LINE__, msg, arg )


/*
** Earg DEPENDENT GLOBAL FUNCTIONS DECLARATION.
*/
static void jobMain(int, char **);
static void set_input(int, char **);
static void set_output(int, char **);
static void set_optionalflag(int, char **);


/*
** COMMAND ARGUMENT PROTOTYPE.
*/
Earg_Cmd command[] =
{
      set_input,             "-in[put] %s",              "", NULL,
      set_output,            "-out[put] %s",             "", NULL,
      set_optionalflag,      "-f[lag] [%d]",             "", NULL,
      jobMain,               "JOBTemplate",              "", NULL,
      EARG_END
};


/*
** Earg DEPENDENT GLOBAL VARIABLES FOR INPUT ARGUMENT.
*/
static char *input     = NULL;
static char *output    = NULL;
static Emsc_Boolean optionalflag = EMSC_FALSE;
```

```
/*
** EXECUTION ENTRY POINT
*/
int main(int argc, char **argv)
{
      /*
      ** DECLARES AND INITIALIZES ALL VARIABLES TO BE USED BY THE OTHER EERR MACROS.
      */
      EERR_INIT("JOBTemplate", &lclerr, lclerr);

      /*
      ** INIT TOOLKIT.
      */
      (void) eint_InitToolkit( (Emsc_Opaque**)&lclerr );
      EERR_CHECK(lclerr, EFS0("ERROR eint_InitToolkit"));

      /*
      ** REGISTER WITH THE SESSION MANAGER AS A JOB.
      */
      esmg_JobInit("JOBTemplate", &lclerr);
      EERR_CHECK(lclerr, EFS0("Error esmg_JobInit"));

      /*
      ** PARSE THE COMMAND LINE BASED ON THE PROTOTYPE.
      */
      earg_DoArgs(command, argc, argv, &lclerr);

      /*
      ** ANNOUNCE THAT THE JOB IS DONE.
      */
      esmg_JobEnd(&lclerr);
      EERR_CHECK(lclerr, EFS0("Error esmg_JobEnd"));

cleanup:
      EERR_SHOW(lclerr, EERR_DEBUG);
      return -1;
}


/*
** Earg DEPENDENT FUNCTION - INPUT
*/
static void set_input(int argc, char **argv)
{
      input = estr_Duplicate(argv[1]); //DUPLICATE STRING, RETURN PINTER TO INPUT.
      return;
}


/*
** Earg DEPENDENT FUNCTION - OUTPUT
*/
static void set_output(int argc, char **argv)
{
      output = estr_Duplicate(argv[1]);  //DUPLICATE STRING, RETURN PINTER TO INPUT.
      return;
}


/*
** Earg DEPENDENT FUNCTION - FLAG
```

```
*/
static void set_optionalflag(int argc, char **argv)
{
	if (argc == 1)
	{
		optionalflag = EMSC_TRUE; // DEFAULT
	}
	else
	{
		if (estr_Eqic(argv[1], "1")) // COMPARE STRING, CASE INSENSITIVE.
			optionalflag = EMSC_TRUE;
		else if (estr_Eqic(argv[1], "0"))
			optionalflag = EMSC_FALSE;
		else
			optionalflag = EMSC_TRUE;
	}
	return;
}


/*
** Earg DEPENDENT FUNCTION - THE CORE PROCESS ENTRY POINT.
** THE HEART OF THE PROCESSING !
*/
static void jobMain(int argc, char **argv)
{
	EERR_INIT("jobMain", &lclerr, lclerr);

	if (input)
	{
		esmg_LogMessage(ESMG_LOG_TERSE, &lclerr, "YOUR INPUT IS: %s", input);
		EERR_CHECK(lclerr, EFS0("ERROR esmg_LogMessage"));
	}
	if (output)
	{
		esmg_LogMessage(ESMG_LOG_TERSE, &lclerr, "YOUR OUTPUT IS: %s", output);
		EERR_CHECK(lclerr, EFS0("ERROR esmg_LogMessage"));
	}
	if (optionalflag)
	{
		esmg_LogMessage(ESMG_LOG_TERSE, &lclerr, "YOU SELECTED THE FLAG!", NULL);
		EERR_CHECK(lclerr, EFS0("ERROR esmg_LogMessage"));
	}

cleanup:

	return;
}
```

Code Explanation:

Pseudo-template for Toolkit Job

One of the hurdles in learning to use the IMAGINE Developers' Toolkit is determining what is “setup code” and what is actual “function code”. Since there is no IDE (Integrated Development Environment), which allows this automatically, we created a base template to assist in creating new “JOBs”.

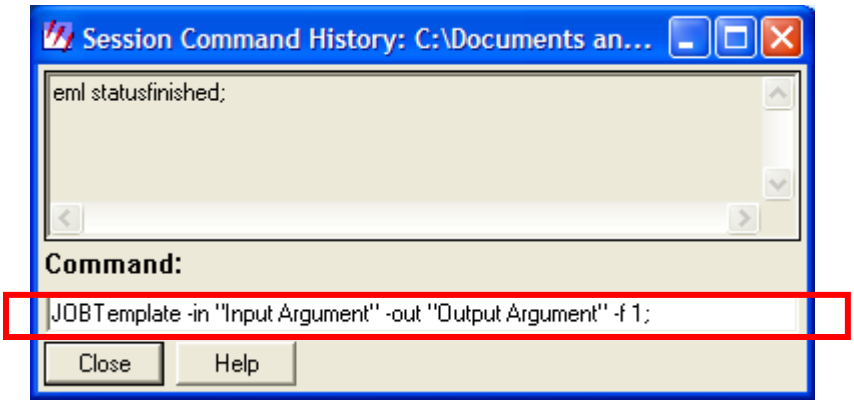
Raster processing via JOBs is a command line process. This means that we need a standard means to process command line arguments. The IMAGINE Developers' Toolkit includes an **earg** package to help manage that process.

The following table is a pseudo-template, which describes the frame work of an IMAGINE JOB. There are a number of basic elements, which we need to identify as part of our program. In the code you should follow the order that appears in the following table.

Components of Pseudo-template	Note
Standard Includes	These standard system header files include sdtio.h.
Toolkit Includes	These must reflect any packages being used in the proceeding code.
Error-Checking Macros	Error-checking is an important part of any Toolkit program.
Earg Dependent Global Function Prototypes	Each element of the command line structure needs to be represented as a global function.
Earg_Cmd Command Structure	Each command line argument and its required inputs will be described in this structure. Each of these inputs must have a function prototype and definition.
Earg Dependent Global Variables	Variables for use in the Earg Global functions. There is a special technique which the earg package uses to set success or failure. Basically, it is set to false at the beginning of the program, and on successful completion, it is set to true.
Main{}	This is the standard entry point of the program. It will usually contain only the **Do_Args** command. This will then execute the earg dependent functions.
Earg Dependent Functions	Each argument on the command line is a function. These functions perform the necessary processing.

How to run a Toolkit JOB

After you compile the program, you can type one of the following commands into the IMAGINE Command line:

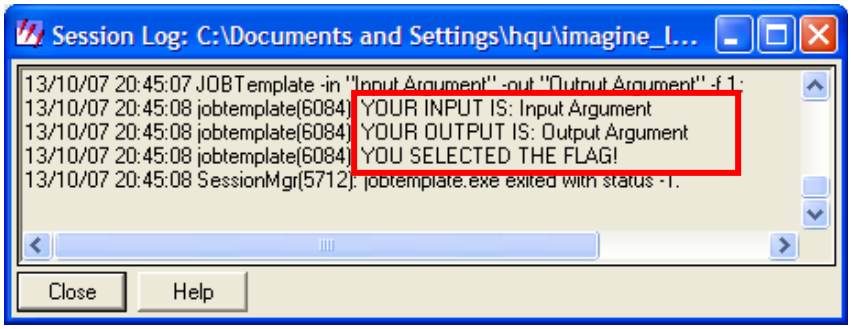



```
JOBTemplate –in “Input Argument” –out “Output Argument” –f 1;
```

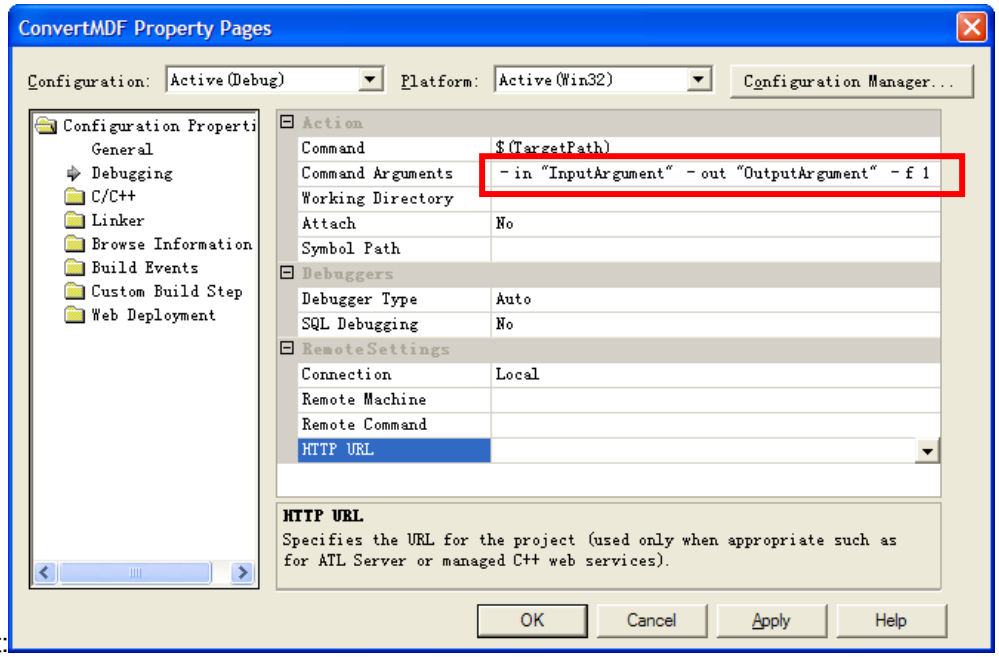
or

```
JOBTemplate –input “Input Argument” –output “Output Argument” –flag 1;
```

You should be able to see the “**YOU SELECTED THE FLAG!**” in the IMAGINE Session log.


Session Log: C:\Documents and Settings\hqu\imagine_I...
13/10/07 20:45:07 JOBTemplate -in "Input Argument" -out "Output Argument" -f 1;
13/10/07 20:45:08 jobtemplate(6084) YOUR INPUT IS: Input Argument
13/10/07 20:45:08 jobtemplate(6084) YOUR OUTPUT IS: Output Argument
13/10/07 20:45:08 jobtemplate(6084) YOU SELECTED THE FLAG!
13/10/07 20:45:08 SessionMgr(5712): jobtemplate.exe exited with status -1.
Close
Help

You can also setup the command arguments into your Microsoft Visual Studio Project setting, and run the JOB from your Visual Studio. The following figure shows how to do:



it:

Earg_Cmd Structure

You will find the following **Earg_Cmd** struct code in this exercise. This code determines how the Toolkit JOB command line is structured.

```
/*
** COMMAND ARGUMENT PROTOTYPE.
*/
Earg_Cmd command[] =
{
    set_input,          "-in[put] %s",          "", NULL,
    set_output,         "-out[put] %s",         "", NULL,
    set_optionalflag,   "-f[lag] [%d]",         "", NULL,
    jobMain,            "JOBTemplate",          "", NULL,
    EARG_END
};
```

The **Earg_Cmd** structure is the heart of the earg package, and is responsible for setting up the command line structure.

"**-in[put] %s**" everything in the bracket(i.e., **[put]**) is optional. You can type either "**-in**" or "**-input**", but you can not type "**-inp**" or "**-inpu**".

"**-f[lag] [%d]**" - "**%d**" is optional, but the argument notification "**-f**" is not optional, the programmer is reponsible for setting a default value in the code.

The prototype string, e.g. "**-in[put] %s**", in the **Earg_Cmd** structure is similar to a print format string in C, in that it contains syntax specification that begins with a percent sign:

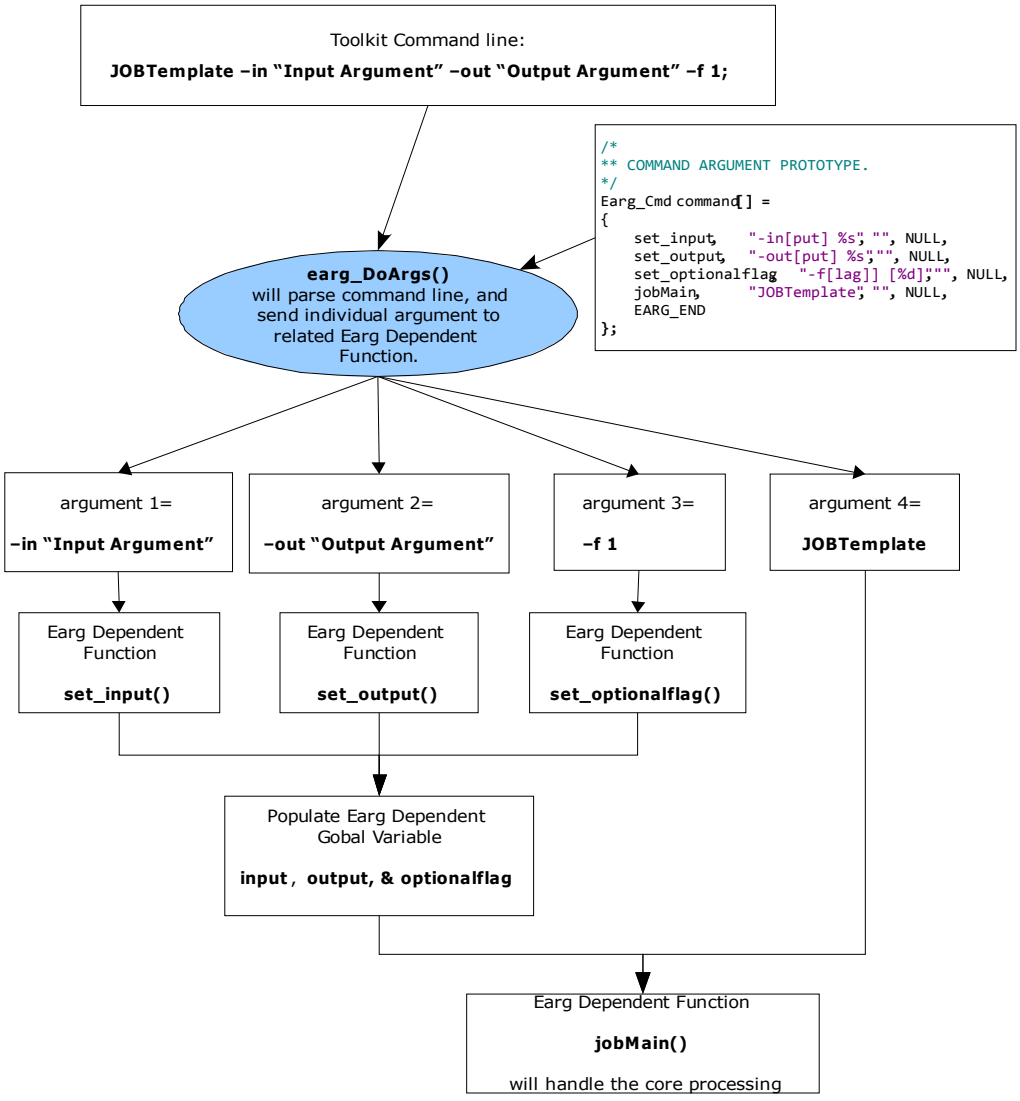
- **%d** - Decimal format number
- **%f** - Floating point number
- **%x** - Hex format number
- **%o** - Octal format number
- **%s** - String of characters

How IMAGINE parse the Toolkit Job command line arguments

The **earg_DoArgs()** is the heat of the IMAGINE command line parser. The **earg_DoArgs()** will split the input, output, optional flag and process commands from the command line, that is why in the Earg dependent function, the **argv[1]** will represent the real argument value.

The following figure shows how **earg_DoArgs()** works.

How earg_DoArgs( ) Parse Command arguments and Process Command



Setup default for OptionalFlag

The following code is a perfect example of a “closed” choice command line argument. You need to be aware that there are two types of command line arguments:

- “**Open**” arguments, such as input and output filenames, can be any valid existing or non-existing filename. If it is an input file then it should exist and should be a valid file.
- “**Closed**” arguments such as pixel types, optional parameters, etc. can only be one of a limited number of choices. The value that is specified on the command line will be checked against a number of valid options, and if valid, the program will proceed. Otherwise it will fail.

```
/*
** Earg DEPENDENT FUNCTION - OUTPUT
*/
static void set_output(int argc, char **argv)
{
    output = estr_Duplicate(argv[1]);
              //DUPLICATE STRING, RETURN PINTER TO INPUT.
    return;
}


/*
** Earg DEPENDENT FUNCTION - FLAG
*/
static void set_optionalflag(int argc, char **argv)
{
    if (argc == 1)
    {
         optionalflag = EMSC_TRUE; // DEFAULT
    }
    else
    {
         if (estr_Eqic(argv[1], "1"))
                    // COMPARE STRING, CASE INSENSITIVE.
              optionalflag = EMSC_TRUE;
         else if (estr_Eqic(argv[1], "0"))
              optionalflag = EMSC_FALSE;
         else
              optionalflag = EMSC_TRUE;
    }
    return;
}
```

In this case, if the user does not specify the argument string (i.e. uses only the **-f**), the default is set to **EMSC_TRUE.**
• If the user specifies 1, on the command line, the option is set to **EMSC_TRUE**.
• If the user specifies 0, on the command line, the option is set to **EMSC_FALSE**.
• If the user specifies anything else, on the command line, the option is set to **EMSC_TRUE**.

Class Notes:

Exercise 3: Basic Programming of the eimg package

Exercise Objective:

In this exercise, we will introduce the basic concept of IMAGINE img files, and basic functionality of eimg package. It is broaked down into 5 parts:
A: Reading Pixel Values From a Layer
B: Reading Pixel Values from a Layer Stack
C: Creating and Writing to Layers
D: Reading other Layer Information e.g. statistics and projection
E: Reading a Descriptor (Attribute) Table

Packages used:

eimg

Introducing an IMAGINE file (*.img)

An IMAGINE file (***.img**) is a self-describing file format, which is organized into layers, that are 2D arrays of pixels; Basically a layer is equivalent to a band or channel; Image data within the layer is stored in tiles, usually **64 x 64** pixels; In addition to image data, IMAGINE layers contain the following data structures:

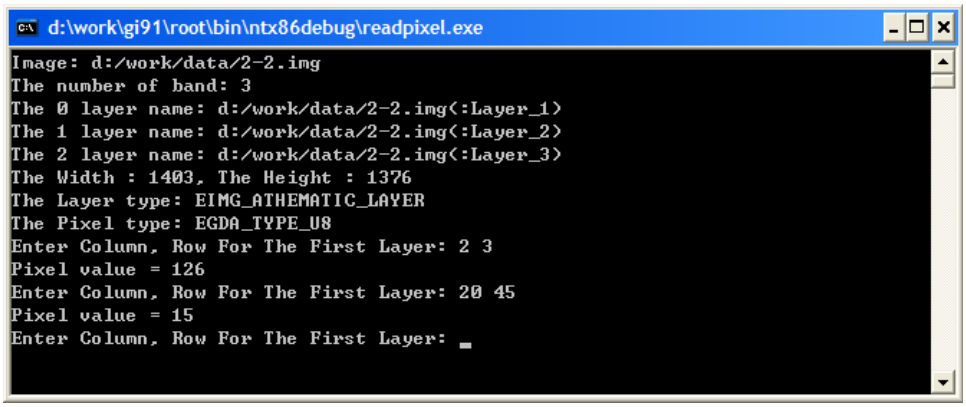
- Image Statistics
- Map and Projection Information
- Descriptor (Attribute) data – colors for thematic image, histogram for athematic image.
- Etc

You can access IMAGINE files by using functions from each of the following packages. The eimg package contains the highest level functions while the efio package contains the lowest level functions.

- **eimg**: high-level access of pixel data, descriptors, map & projection info, stats (Image Info, Descriptor Editor)
- **edsc, esta, eprj**: Access of individual layer elements such as stats, pixels, etc.
- **ehfa**: Hierarchical File Architecture; Organizes a file into a tree-like structure (HFA View)
- **emif**: Machine Independent Format; Takes care of differences between machine & compiler architectures, e.g. byte swapping.
- **efio**: Low-level File I/O

A. Reading Pixel Values From a Layer

In this example (Sec5_03a), we will learn how to read pixel values from a layer, the following figure show the interface of the example:


d:\work\gi91\root\bin\ntx86debug\readpixel.exe
Image: d:/work/data/2-2.img
The number of band: 3
The 0 layer name: d:/work/data/2-2.img(:Layer_1)
The 1 layer name: d:/work/data/2-2.img(:Layer_2)
The 2 layer name: d:/work/data/2-2.img(:Layer_3)
The Width : 1403, The Height : 1376
The Layer type: EIMG_ATHEMATIC_LAYER
The Pixel type: EGDA_TYPE_U8
Enter Column, Row For The First Layer: 2 3
Pixel value = 126
Enter Column, Row For The First Layer: 20 45
Pixel value = 15
Enter Column, Row For The First Layer:

Note: *In order to run program in Console mode, you need to modify project settings in your Microsoft Visusal Studio:*

<1> *Remove the ewinmainlib.lib from Linker; (Linker->Input->Additional Dependencies, remove the ewinmainlib.lib)*

<2> *Change Subsystem to Console; (Linker->System->Subsystem, change to "Console (/SUBSYSTEM:CONSOLE)")*

<3> *Go to IMAGINE Command line, type the following command:*
"c:/windows/system32/cmd.exe"

<4> *In the DOS Console, type the following command:*
"c:\Program Files\ERDAS\ERDAS Desktop 2011\Bin\Win32Debug\readpixel"
"d:/work/data/2-2.img"

Another way to run is to set up the command arguments in your Visual Studio:
Go to project settings->Configuration Properties->Debugging->Command Arguments, and type "d:/work/data/2-2.img" there.

Code Snippet (Sec5_03a)

```
/*****************************************************************************
******************************************************************************
 JOB: readpixel
      PURPOSE: This example shows how to read pixel value from an existing
      image (layer 1 by default) by col and row number.

 CALLING SYNTAX:
      readpixel <inputfile name>

      e.g.
      >readpixel "d:/work/data/2-2.img"
      Enter Column, Row: 100 100      <-Use "space" in between
******************************************************************************
*****************************************************************************/

#define EFIO_STDIO_PROTOTYPES_PASSTHROUGH // WILL ENABLE printf()

#include <stdlib.h>

/*
** TOOLKIT INCLUDES
*/
#include <eint.h> // TOOLKIT INITIALIZATION PACKAGE.
#include <eerr.h> // ERROR LOGGING AND REPORTING PACKAGE.
#include <esmg.h> // SESSION MANAGER API PACKAGE.
#include <emsc.h> // MISCELLANEOUS FUNCTIONS FOR COMMON OPERATIONS.
#include <estr.h> // STRING PACKAGE.
#include <egda.h> // DEFINE PIXEL TYPE
#include <eimg.h> // HIGH LEVEL API TO CREATE OR ACCESS IMG FILES


/*
** ERROR CHECKING MACROS.
*/
#define EFS0( msg ) EERR_FATAL_SET_0( __LINE__, msg )
#define EFS1( msg, arg ) EERR_FATAL_SET_1( __LINE__, msg, arg )

static int                  rc = -1;
```

```
/*
** EXECUTION ENTRY POINT
*/
int main(int argc, char **argv)
{
      long  column, row;
      long  width, height;
      int         i;
      int         exit=0;

      Estr_StringList   *           layernames = NULL;
      Eimg_Layer *                  layer = NULL;
      Eimg_PixelRect    *           pixel = NULL;

      /*
      ** DECLARES, INITIALIZES ALL VARIABLES TO BE USED BY THE OTHER EERR
      **    MACROS.
      */
      EERR_INIT("readpixel", &lclerr, lclerr);

      /*
      ** SETUP THE BASE APPLICATION ENVIRONMENT, THIS INCLUDES CONNECTION FOR
      **    SESSION MANAGER, ENVIRONMENT VARIABLES, REGISTER RASTER FROMAT DLLS, ETC...
      */
      esmg_ApplicationInit(NULL);

      /*
      ** INIT TOOLKIT.
      */
      (void) eint_InitToolkit( (Emsc_Opaque**)&lclerr );
      EERR_CHECK(lclerr, EFS0("ERROR eint_InitToolkit"));


      /*
      ** GET ALL LAYER NAMES
      */
      layernames = eimg_LayerGetNames(argv[1], eint_GetInit(), &lclerr);
      //layernames = eimg_LayerGetNames("d:/work/data/example/2-2.img", eint_GetInit(),
&lclerr);
      EERR_CHECK(lclerr, EFS0("ERROR eimg_LayerGetNames"));

      printf("Image: %s\n", argv[1]);
      printf("The number of band: %d\n",layernames->count);
      for (i =0; i< layernames->count; i ++)
      {
            printf("The %d layer name: %s\n", i, layernames->strings[i]);
      }


      /*
      ** OPEN THE FIRST LAYER
      */
      layer = eimg_LayerOpen(layernames->strings[0], eint_GetInit(),
            &lclerr, EIMG_LAYER_OPTION_READONLY,
            EIMG_LAYER_OPTION_END);
      EERR_CHECK(lclerr, EFS0("ERROR eimg_LayerOpen"));

      printf("The Width : %d, The Height : %d\n", layer->width, layer->height);
      switch ( layer->layerType ) //Eimg_LayerType
      {
```

```
            case EIMG_THEMATIC_LAYER:
                  printf ("The Layer type: EIMG_THEMATIC_LAYER\n"); break;
            case EIMG_ATHEMATIC_LAYER:
                  printf ("The Layer type: EIMG_ATHEMATIC_LAYER\n"); break;
            default: printf("Other Enum value\n");
      }
      switch ( layer->pixelType ) //Egda_PixelType
      {
            case EGDA_TYPE_U8:
                  printf ("The Pixel type: EGDA_TYPE_U8\n"); break;
            case EGDA_TYPE_U16:
                  printf ("The Pixel type: EGDA_TYPE_U16\n"); break;
            default: printf("Other Enum value\n");
      }


      /*
      ** ALLOCATE SPACE FOR THE PIXEL TO BE READ
      */
      pixel = eimg_PixelRectCreate( 1, 1, EGDA_TYPE_F32, &lclerr);
      EERR_CHECK(lclerr, EFS0("ERROR eimg_PixelRectCreate"));


      /*
      ** ACCESS PIXEL VALUE BY COLUMN AND ROW.
      */
      while (!exit)
      {
            printf("Enter Column Row For The First Layer, type -1 -1 to exit:");
            scanf("%d %d", &column, &row);
            if (column != -1)
            {
                  //Read Pixel Value into (Eimg_PixelRect  *) Structure
                  eimg_LayerRead( layer, column, row, 1 , 1, pixel, &lclerr);
                  EERR_CHECK(lclerr, EFS0("ERROR eimg_LayerRead"));

                  //Access (Eimg_PixelRect     *) Structure
                  printf( "Pixel value = %g\n", *((Egda_F32 *)EIMG_DATAPTR(pixel, 0,0)) );
            }
            else
            {
                  exit=1;
                  break;
            }
      }
      rc = 1;

cleanup:

      EERR_SHOW(lclerr, EERR_DEBUG);

      if (layer)
      {
            eimg_LayerClose(layer, &lclerr);
            EERR_DELETE( lclerr );
            layer = NULL;
      }
      if (pixel)
      {
            eimg_PixelRectDelete(pixel, &lclerr);
            EERR_DELETE( lclerr );
```

```
            pixel = NULL;
      }
      if (layernames)
      {
            estr_StringListDelete( layernames, &lclerr);
            EERR_DELETE( lclerr );
            layernames = NULL;
      }

      /*
      ** return 0 when job finish successfully
      ** return -1 when failed.
      */
      return rc;
}
```

Code Explanation:

The eimg Package

The eimg package is used to access layer information. Since layers are accessed by name, the first thing we need is a listing of layer names in a file. To do this, we use the eimg_LayerGetNames() function to find layer names

The layer name looks like "**d:/data/lanier.img(:Layer_1)**", "**d:/datalanier.img(:Layer_2)**". The layername string contains both the path name of the file containing the layer, and the ehfa path name within the file which identifies the layer.

Eimg_LayerGetNames()

The prototype of this API is:

```
Estr_StringList * eimg_LayerGetNames(Etxt_Text filename,
    Eint_InitToolkitData *erdinit,
    Eerr_ErrorReport **inerrorreport)
```

This function finds the names of all layers in file **filename**. A string lsit containing the list of laye names will be returned; if an error occurs, a NULL string list is returned and **inerrorreport** is set to reflect the error.

Each layer name is a string, **eimg_LayerGetNames()** allocates and returns a pointer to an **Estr_StringList** structure containing the layernames. When we're done, we free the stringlist by using **Estr_StringListDelete()**.

eimg_LayerOpen()

In order to access data from a layer, it must be opened. We can open, read, write, and close layers much like files. Layers can be opened by using the **eimg_LayerOpen()** function;

The prototype of this API is:

```
Eimg_Layer * eimg_LayerOpen( Etxt_Text totalName,
              Eint_InitToolkitData *erdInit,
              Eerr_ErrorReport**inerr,
               va_dcl)
```

This function will open an eimg layer, and a pointer to an **Eimg_Layer** structure is allocated and returned.

The last item in the argument list for this function must be **EIMG_LAYER_OPTION_END**. All options which may appear in the variable-length argument for the function **eimg_LayerOpen** may be found at emun type **Eimg_LayerOption** in "**eimg.h**", you may also find them in the reference.

There are many of them, but the ones we'll need now (or soon) are:

```
EIMG_LAYER_OPTION_READONLY
```
Allow only read-only access; no additional arguments.

```
EIMG_LAYER_OPTION_COMPUTE_STATS_ON_CLOSE
```
Recompute layer statistics and store them on disc when the layer is closed; no additional arguments.

```
EIMG_LAYER_OPTION_END
```
End of option list; no additional arguments.

Eimg_Layer

An **Eimg_Layer** layer is a two-dimensional array of raster data, one element in the array for each image pixel.

For example, a true color RGB image stored in such an eimg file would have three layers: one for each of the red, green, and blue bands. Different layers in an eimg file can be composed of pixels with different data types and the layers need not have the same number of pixels horizontally and vertically. The pixels of a raster layer are partitioned into rectangular blocks, with all blocks having the same width and height (in pixels). Pixels are read from or written to the layer through the **eimg_LayerRead()** or **eimg_LayerWrite()** functions.

```
struct EIMG_LAYER {
      long width; /* Width (in pixels) of the layer */
      long height; /* Height (in pixels) of the layer */
      Eimg_LayerType layerType; /* Type of layer (e.g., thematic) */
      Egda_PixelType pixelType; /* Type of pixels in this layer
```

```
      (e.g.,unsigned 8-bit) */
      ...
} Eimg_Layer
```

While the **Eimg_LayerType** is an enumeration, we will discuss it in the next exercise.

```
typedef enum {
      EIMG_THEMATIC_LAYER = 0, /* Data is thematic (i.e., each pixel
      ** value is the index of a class) */
      EIMG_ATHEMATIC_LAYER /* Data is a measurement of some sort */
} Eimg_LayerType
```

The **Egda_PixelType** defines the type of data we're working with. Usually it is defined as **EGDA_TYPE_U8**, which means unsigned eight bit (i.e., 0..255). We will discuss it in more details in next exercise.

---

eimg_LayerClose()

Eimg_LayerClose() closes a layer, and frees the **Eimg_Layer** memory. It can also do other things, such as computing statistics on the layer. This is achieved by modifying the argument options.

The prototype of this API is:

```
void eimg_LayerClose( Eimg_Layer *layer, Eerr_ErrorReport **errptr)
```

This function closes a layer previously opened by a call to **eimg_LayerCreate()** or **eimg_LayerOpen()**. It additionally releases the memory occupied by the layer's **Eimg_Layer** structure. Note this API doesn't set the layer to NULL.

Reading Pixel Values from a Layer

The **eimg_LayerRead()** function is used to read a rectangle of pixel values from a layer to a buffer.

---

eimg_LayerRead()

The prototype of this API is:

```
void eimg_LayerRead( Eimg_Layer       *layer,
     long             xInit,
     long             yInit,
     long             w,
     long             h,
     Eimg_PixelRect        *pixelRect,
     Eerr_ErrorReport  **inerr)
```

This function retrieves a rectangle of pixels from a layer. This function returns the value of all pixels (x.y) within the rectangle specified by xInit<= x <= XInit + w -1, yInit <= y <= yInit + h -1.

Reading beyond the bounds of a layer is perfectly O.K.; **eimg_LayerRead** will return zero for these pixels (This boundary value can be changed using the layer option **EIMG_LAYER_OPTION_BOUNDARY_VALUE**)

The value of the boundary value (set via the variable argument lists of **eimg_LayerOpen**, **eimg_LayerCreate**, or **eimg_LayerChangeOptions**) is returned. Note that zero will be used as the default boundary value if the user doesn't explicitly specify a value.

Eimg_PixelRect

Eimg_PixelRect is identical to the **Egda_BaseData** structure, since **Eimg_PixelRect** is typedef'd to the **Egda_BaseData** type.

Egda_BaseData is a structure used to contain scalar, vector (table), matrix, or raster data. The **Eimg_PixelRect** structure can store a rectangular array of pixels of any of the supported pixel types (e.g., 8-bit unsigned integer, 64-bit floating point ...).

The prototype of this structure is:

```
typedef struct
{
   long              numrows;
   long              numcolumns;
   Egda_PixelType    datatype;
   Egda_ObjectType   objecttype;
   Egda_Byte *       data;     /* pointer to the data array */
   Egda_Byte *       currentData;    /* can be set to point to anywhere
                                        within data array */
   long              pitch;          /* Number of bytes between rows */
   Emsc_Boolean      derivedFlag;    /* indicate data array is derived
                                        or not */
   long              numelements;    /* total elements in data array */
   long              numbytes;  /* number of bytes per-pixel  */
   Emsc_Opaque *     userdata;  /* user specicied data pointer */
} Eimg_PixelRect;
```

---

eimg_PixelRectCreate()

Egda_PixelRect are created and deleted using eimg_PixelRectCreate() and eimg_PixelRectDelete():

The prototype of this API is:

```
Eimg_PixelRect * eimg_PixelRectCreate(long width,long height, Egda_PixelType
pixelType, Eerr_ErrorReport **errptr)
```

This function creates a structure with can store raster data. Storage is allocated for height rows of raster data, each containing width pixel of type pixeltype.

NULL is returned if an error occurs while trying to create the buffer. Otherwise, a pointer to the resulting **Eimg_PixelRect** structure is returned.

eimg_PixelRectDelete()

The prototype of this API is:

```
void eimg_PixelRectDelete( Eimg_PixelRect *pixelRect, Eerr_ErrorReport **er-
rptr)
```

This function deletes the buffer ***pixelRect*** which had been created with the function ***eimg_PixelRectCreate()***.

Note: The pixelRect is created with a floating point data type in our next example:

```
eimg_PixelRectCreate( 1, 1, EGDA_TYPE_F32, &lclerr);
```

Why? Since **eimg_LayerRead()** automatically converts the data type to that of the pixelRect, we will not loose precision converting any layers up to F32. (We're just printing out values here.)

How do we access individual pixel values in an **Eimg_PixelRect**?

Use **EIMG_DATAPTR(pixrect, column, row**): this macro returns a pointer to the pixel value at (column, row) of pixelRect. You still need to properly cast this value to the correct data type and dereference it.

For example, if you had an eimg_PixelRect structure holding signed 16-bit values and you wanted the value at row 5 and column 12, you would use the **Egda_S16** value;

```
value = *((Egda_S16 *)EIMG_DATAPTR( PIXRECT, 12, 5 ));
```

Egda_S16 is a datatype (typedef'd to a signed short integer on most machines), while **EGDA_TYPE_S16** is an entry within the **Egda_PixelType** enumeration;

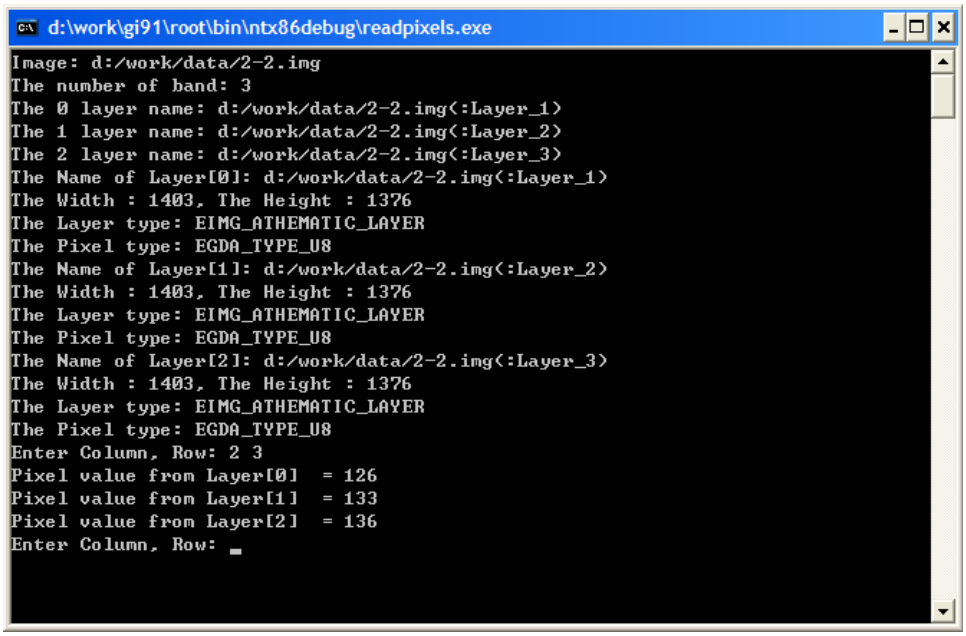
EIMG_DATAPTR

The prototype of this MACRO is:

```
#define EIMG_DATAPTR(RECT,COLUMN,ROW) \
        ( ((RECT)->currentData) + (ROW)*((RECT)->pitch) + \
       (COLUMN)*((RECT)->numbytes) )
```

B. Reading Pixel Values From a Layer Stack

In our next example (Sec5_03b), we will learn how to read pixel values from a layerstack, the following figure show the interface of the example:


d:\work\gi91\root\bin\ntx86debug\readpixels.exe
Image: d:/work/data/2-2.img
The number of band: 3
The 0 layer name: d:/work/data/2-2.img(:Layer_1)
The 1 layer name: d:/work/data/2-2.img(:Layer_2)
The 2 layer name: d:/work/data/2-2.img(:Layer_3)
The Name of Layer[0]: d:/work/data/2-2.img(:Layer_1)
The Width : 1403, The Height : 1376
The Layer type: EIMG_ATHEMATIC_LAYER
The Pixel type: EGDA_TYPE_U8
The Name of Layer[1]: d:/work/data/2-2.img(:Layer_2)
The Width : 1403, The Height : 1376
The Layer type: EIMG_ATHEMATIC_LAYER
The Pixel type: EGDA_TYPE_U8
The Name of Layer[2]: d:/work/data/2-2.img(:Layer_3)
The Width : 1403, The Height : 1376
The Layer type: EIMG_ATHEMATIC_LAYER
The Pixel type: EGDA_TYPE_U8
Enter Column, Row: 2 3
Pixel value from Layer[0] = 126
Pixel value from Layer[1] = 133
Pixel value from Layer[2] = 136
Enter Column, Row:

Code Snippet (Sec5_03b)

```
/*****************************************************************************
******************************************************************************
 JOB: readpixels
      PURPOSE: This example shows how to read pixel value from an existing
      image (all layers)  by col and row number.

 CALLING SYNTAX:
      readpixels <inputfile name>

      e.g.
      >readpixels "d:/work/data/2-2.img"
      Enter Column, Row: 100 100      <-Use "space" in between
******************************************************************************
******************************************************************************/

#define EFIO_STDIO_PROTOTYPES_PASSTHROUGH  // WILL ENABLE printf()

#include <stdlib.h>
#include <time.h>
/*
** TOOLKIT INCLUDES
*/
#include <eint.h> // TOOLKIT INITIALIZATION PACKAGE.
#include <eerr.h> // ERROR LOGGING AND REPORTING PACKAGE.
#include <esmg.h> // SESSION MANAGER API PACKAGE.
#include <emsc.h> // MISCELLANEOUS FUNCTIONS FOR COMMON OPERATIONS.
#include <estr.h> // STRING PACKAGE.
#include <egda.h> // DEFINE PIXEL TYPE
#include <eimg.h> // HIGH LEVEL API TO CREATE OR ACCESS IMG FILES
```

```
/*
** ERROR CHECKING MACROS.
*/
#define EFS0( msg ) EERR_FATAL_SET_0( __LINE__, msg )
#define EFS1( msg, arg ) EERR_FATAL_SET_1( __LINE__, msg, arg )

static int                  rc = -1;


/*
** EXECUTION ENTRY POINT
*/
int main(int argc, char **argv)
{
      long  nlayers, column, row;
      long  width, height;
      char  buf[25];
      int         i;
      int         exit=0;

      Estr_StringList   *           layernames = NULL;
      Eimg_LayerStack   *           layerstack = NULL;
      Eimg_PixelRectStack     *     pixelstack = NULL;

      /*
      ** DECLARES, INITIALIZES ALL VARIABLES TO BE USED BY THE OTHER EERR
      **    MACROS.
      */
      EERR_INIT("readpixel", &lclerr, lclerr);

      /*
      ** SETUP THE BASE APPLICATION ENVIRONMENT, THIS INCLUDES CONNECTION FOR
      **    SESSION MANAGER, ENVIRONMENT VARIABLES, REGISTER RASTER FROMAT DLLS, ETC...
      */
      esmg_ApplicationInit(NULL);

      /*
      ** INIT TOOLKIT.
      */
      (void) eint_InitToolkit( (Emsc_Opaque**)&lclerr );
      EERR_CHECK(lclerr, EFS0("ERROR eint_InitToolkit"));


      /*
      ** GET ALL LAYER NAMES
      */
      layernames = eimg_LayerGetNames(argv[1], eint_GetInit(), &lclerr);
      EERR_CHECK(lclerr, EFS0("ERROR eimg_LayerGetNames"));

      printf("Image: %s\n", argv[1]);
      printf("The number of band: %d\n",layernames->count);
      for (i =0; i< layernames->count; i ++)
      {
            printf("The %d layer name: %s\n", i, layernames->strings[i]);
      }


      /*
      ** OPEN ALL LAYERS
      */
      layerstack = eimg_LayerStackOpen(layernames, eint_GetInit(),
```

```
            &lclerr, EIMG_LAYER_OPTION_READONLY,
            EIMG_LAYER_OPTION_END);
      EERR_CHECK(lclerr, EFS0("ERROR eimg_LayerStackOpen"));

      for (i=0; i<layernames->count; i ++)
      {
            printf("The Name of Layer[%d]: %s\n",
                  i,
                  layerstack->layers[i]->fullName);
            printf("The Width : %d, The Height : %d\n",
                  layerstack->layers[i]->width,
                  layerstack->layers[i]->height);
            switch ( layerstack->layers[i]->layerType ) //Eimg_LayerType
            {
                  case EIMG_THEMATIC_LAYER:
                        printf ("The Layer type: EIMG_THEMATIC_LAYER\n"); break;
                  case EIMG_ATHEMATIC_LAYER:
                        printf ("The Layer type: EIMG_ATHEMATIC_LAYER\n"); break;
                  default: printf("Other Enum value\n");
            }
            switch ( layerstack->layers[i]->pixelType ) //Egda_PixelType
            {
                  case EGDA_TYPE_U8:
                        printf ("The Pixel type: EGDA_TYPE_U8\n"); break;
                  case EGDA_TYPE_U16:
                        printf ("The Pixel type: EGDA_TYPE_U16\n"); break;
                  default: printf("Other Enum value\n");
            }
      }


      /*
      ** ALLOCATE SPACE FOR THE PIXEL (For All Layers) TO BE READ
      */
      pixelstack = eimg_PixelRectStackCreate( layernames->count, 1, 1,
                              EGDA_TYPE_F32, &lclerr);
      EERR_CHECK(lclerr, EFS0("ERROR eimg_PixelRectStackCreate"));

      while (1)
      {
            printf("Enter Column, Row (type -1 -1 to exit): ");
            scanf("%d %d", &column, &row);
            if (column != -1)
            {
                  eimg_LayerStackRead( layerstack, column, row, 1 , 1, pixelstack, &lclerr);
                  EERR_CHECK(lclerr, EFS0("ERROR eimg_LayerRead"));

                  for ( i =0; i<pixelstack->numlayers; i++)
                  {
                        printf( "Pixel value from Layer[%d]  = %g\n",
                                    i,
                                    *((Egda_F32 *)EIMG_DATAPTR(pixelstack->datalayer[i],
0,0)) );
                  }
            }
            else
            {
                  exit=1;
                  break;
            }
      }
```

```
	rc = 1;

cleanup:

	EERR_SHOW(lclerr, EERR_DEBUG);
	if (layerstack)
	{
		eimg_LayerStackClose(layerstack, &lclerr);
		EERR_DELETE( lclerr );
		layerstack = NULL;
	}
	if (pixelstack)
	{
		eimg_PixelRectStackDelete(pixelstack, &lclerr);
		EERR_DELETE( lclerr );
		pixelstack = NULL;
	}
	if (layernames)
	{
		estr_StringListDelete( layernames, &lclerr);
		EERR_DELETE( lclerr );
		layernames = NULL;
	}
	/*
	** return 0 when job finish successfully
	** return -1 when failed.
	*/
	return rc;
}
```

Code Explanation:

Reading Pixel Values from a LayerStack

The **eimg_LayerStackRead()** function is used to read a rectangle of pixel values from a layerstack to a buffer. It reads from all layers instead of one layer.

eimg_LayerStackOpen()

The prototype of this API is:

```
Eimg_LayerStack * eimg_LayerStackOpen( Eimg_LayerNameStack *totalNames,
                Eint_InitToolkitData *erdInit,
                Eerr_ErrorReport **inerr, ... )
```

This function will open an eimg layer stack, and a pointer to an **Eimg_LayerStack** structure is allocated and returned.

Eimg_LayerStack

The prototype of this Structure is:

```
typedef struct _eimg_LayerStack {
    long count;              /* Number of layers in this stack */
    Eimg_Layer **layers;  /* Pointer to array of layer pointers */
       ...
} Eimg_LayerStack;
```

The **Eimg_LayerStack** structure is used to represent an array of **Eimg_Layer** structures. All **Eimg_Layer** structure pointed to **Eimg_LayerStack** structure should beof the same pixel type and have the same number of pixels horizontally and vertically.

eimg_LayerStackRead()

The prototype of this API is:

```
void eimg_LayerStackRead( Eimg_LayerStack       *layerStack,
      long              xInit,
      long              yInit,
      long              w,
      long              h,
      Eimg_PixelRectStack    *pixelRectStack,
      Eerr_ErrorReport  **inerr)
```

This function returns the value of all pixels (x.y) within the rectangle specified by **xInit**<= x <= **XInit** + **w** -1, **yInit** <= y <= **yInit** + **h** -1 for each layer in the stack.

Eimg_PixelRectStack

The prototype of this structure is:

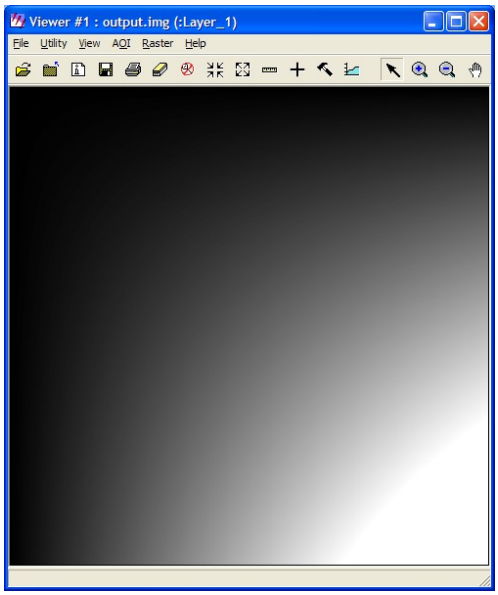
```
typedef struct {
  long numlayers;
  Emsc_Boolean derivedFlag;
  Egda_BaseData **datalayer;
  Emsc_Opaque   *userdata;   /* user specicied data pointer */
} Egda_BaseDataStack;
```

Egda_PixelRectStack data type represents the multiple layers of BaseData, it can be created and deleted by using **eimg_PixelRectStackCreate()** and **eimg_PixelRectStackDelete()**.

C: Creating and Writing to Layers

In our next example (Sec5_03c), we will learn how to create a IMAGINE (*.**img**) file. The IMAGINE file will have **512x512** pixels in which the value of each pixel is the product of its row and column value.

The following figure shows the IMAGINE file created by this program:



Code Snippet (Sec5_03c)

```
/*****************************************************************************
******************************************************************************
 JOB: writepixel
      PURPOSE: This example creates an Imagine file (512x512) in which the value of each pixel
      is the product of its row and column value.

 CALLING SYNTAX:
      writepixel <outputfile name>

      e.g.
      writepixel "d:/work/datat/out.img"
******************************************************************************
*****************************************************************************/

#define EFIO_STDIO_PROTOTYPES_PASSTHROUGH // WILL ENABLE printf()

#include <stdlib.h>

/*
** TOOLKIT INCLUDES
*/
```

```c
#include <eint.h> // TOOLKIT INITIALIZATION PACKAGE.
#include <eerr.h> // ERROR LOGGING AND REPORTING PACKAGE.
#include <esmg.h> // SESSION MANAGER API PACKAGE.
#include <emsc.h> // MISCELLANEOUS FUNCTIONS FOR COMMON OPERATIONS.
#include <estr.h> // STRING PACKAGE.
#include <egda.h> // DEFINE PIXEL TYPE
#include <eimg.h> // HIGH LEVEL API TO CREATE OR ACCESS IMG FILES


/*
** ERROR CHECKING MACROS.
*/
#define EFS0( msg ) EERR_FATAL_SET_0( __LINE__, msg )
#define EFS1( msg, arg ) EERR_FATAL_SET_1( __LINE__, msg, arg )

static int  rc = -1;


/*
** EXECUTION ENTRY POINT
*/
int main(int argc, char **argv)
{
      long  column, row;
      long  width, height;
      int   i;

      char  *                     layername = NULL;
      Eimg_Layer *                layer = NULL;
      Eimg_PixelRect    *         pixel = NULL;

      /*
      ** DECLARES, INITIALIZES ALL VARIABLES TO BE USED BY THE OTHER EERR
      **    MACROS.
      */
      EERR_INIT("writepixel", &lclerr, lclerr);

      /*
      ** SETUP THE BASE APPLICATION ENVIRONMENT, THIS INCLUDES CONNECTION FOR
      **    SESSION MANAGER, ENVIRONMENT VARIABLES, REGISTER RASTER FROMAT DLLS, ETC...
      */
      esmg_ApplicationInit(NULL);

      /*
      ** INIT TOOLKIT.
      */
      (void) eint_InitToolkit( (Emsc_Opaque**)&lclerr );
      EERR_CHECK(lclerr, EFS0("ERROR eint_InitToolkit"));


      /*
      ** GET ALL LAYER NAMES
      */
      layername = estr_StringCat (NULL,  argv[1], "(:Layer_1)");
            //Concatenate 2 strings, allocate memory and return its pointer.

      /*
      ** OPEN THE FIRST LAYER
      */
      layer = eimg_LayerCreate (layername,
            EIMG_ATHEMATIC_LAYER, EGDA_TYPE_F32,
```

```
            512, 512,
            eint_GetInit(), &lclerr,
            EIMG_LAYER_OPTION_COMPUTE_STATS_ON_CLOSE,
            EIMG_LAYER_OPTION_END);
      EERR_CHECK(lclerr, EFS0("ERROR eimg_LayerCreate"));

      /*
      ** ALLOCATE SPACE FOR THE PIXEL TO BE WRITE (ONE FULL ROW)
      */
      pixel = eimg_PixelRectCreate( layer->width, 1, layer->pixelType, &lclerr);
      EERR_CHECK(lclerr, EFS0("ERROR eimg_PixelRectCreate"));


      /*
      ** WRITE LAYER
      */
      for (row = 0; row< layer->height; row ++)
      {
            /*
            ** Assign pixel value to row
            */
            for ( column = 0; column< layer->width; column ++)
            {
                  *((Egda_F32 *)EIMG_DATAPTR(pixel, column,0)) = column * row;
            }
            /*
            ** Write the row to layer
            */
            eimg_LayerWrite( layer, 0, row, layer->width, 1, pixel, &lclerr);
      }

      rc = 1;

cleanup:

      EERR_SHOW(lclerr, EERR_DEBUG);
      if (layer)
      {
            eimg_LayerClose(layer, &lclerr);
            EERR_DELETE( lclerr );
            layer = NULL;
      }
      if (pixel)
      {
            eimg_PixelRectDelete(pixel, &lclerr);
            EERR_DELETE( lclerr );
            pixel = NULL;
      }
      if (layername)
      {
            emsc_Free(layername);
            layername = NULL;
      }

      /*
      ** return 0 when job finish successfully
      ** return -1 when failed.
      */
      return rc;
}
```

Code Explanation:

Creating and Writing to layers

The eimg_LayerCreate function is used to create a new layer:

---

eimg_LayerCreate()

The prototype of this API is:

```
Eimg_Layer * eimg_LayerCreate( Etxt_Text totalName, Eimg_LayerType inLayerType,
                Egda_PixelType inPixelType, long inNPixX, long inNPixY,
                Eint_InitToolkitData *erdInit, Eerr_ErrorReport **errptr,
                ... )
```

This function will create and open a layer of raster data in an image file, and a layer pointer will be returned.

totalName string includes both the file path name and the HFA node name for the layer, so it looks like this "**D:/Work/Data/Demo.img(:Band_1)**"

inLayerType is the image type, can be **EIMG_THEMATIC_LAYER, EIMG_ATHEMATIC_LAYER** or **EIMG_REALFFT_LAYER**.

inPixelType is the pixel depth, in our exercise it can be either **EGDA_TYPE_U8** or **EGDA_TYPE_U16**.

inNPixX is the number of columns in that layer.

inNPixY is the number of rows in that layer.

erdInit is the global pointer (**Eint_InitToolkitData ***) of toolkit initialization structure, usually **eint_GetInit()** will return that global pointer. The reason why this argument is involved is because eimg package need the ehfa, esta core packages, so the valid (**Eint_InitToolkitData ***) pointer will ensure this prerequisite condition.

... is the variable argument list. They are defined at enum type **Eimg_LayerOption** (in "**eimg.h**")

EIMG_LAYER_OPTION_COMPUTE_STATS_ON_CLOSE option will recompute layer statistics and store them on disc when the layer is closed.

EIMG_LAYER_OPTION_END option will always at the end of variable argument list.

Note: The last item in the argument list for this function must be **EIMG_LAYER_OPTION_END**. All options which may appear in the variable-length argument for the function **eimg_LayerOpen** may be found at emun type **Eimg_LayerOption** in "**eimg.h**", you may also find them in the reference.

eimg_LayerWrite()

The prototype of this API is:

```
void eimg_LayerWrite( Eimg_Layer *layer, long xInit, long yInit,
                      long numPixelsX, long numPixelsY,
                      Eimg_PixelRect *pixelRect,
                      Eerr_ErrorReport**errptr)
```

This function stores values at pixel positions (**xInit**, **yInit**) within the rectangle specified by **xInit** + **numberPixelsX** -1, **yInit** + **numberPixelsY** -1. For positions beyond the area of valid data, this function has no effect.

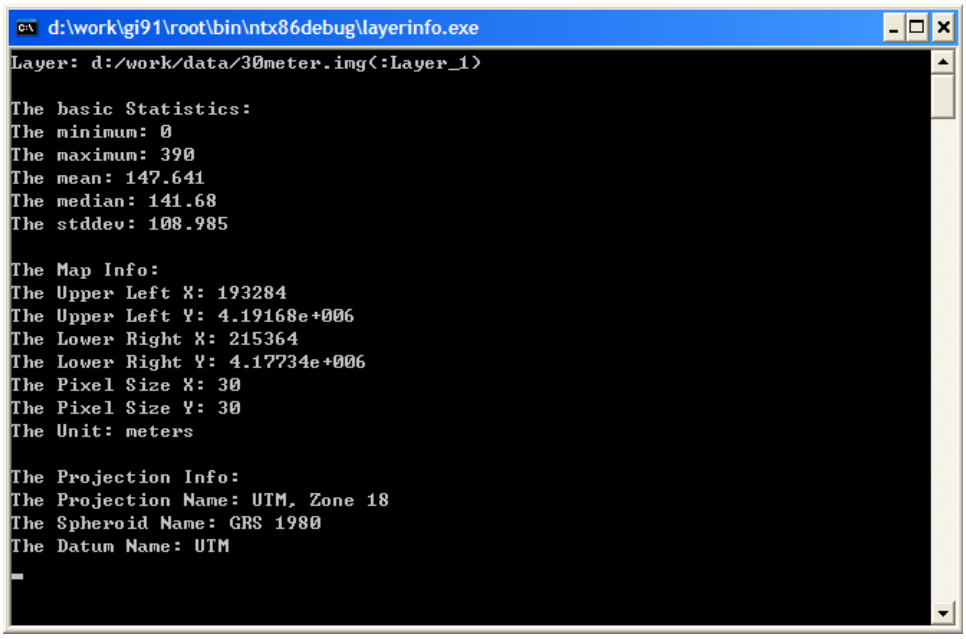
Note:

1. The data . the data are retrieved from the source **pixelRect** at the position specified by **pixelRect->CurrentData**.
2. Each row in the source **pixelRect** is comprised of **pixelRect->pitch** bytes. Thus, regardless of the values of **numberPixelsX** and **numberPixelsY**

D. Reading other Layer Information e.g. statistics and projection

In our next example (Sec5_03d), we will learn how to read basic statistics, map information and projection information from img file.

The following figure shows the interface of the program:



Code Snippet (Sec5_03d)

```
/*****************************************************************************
******************************************************************************
 JOB: layerinfo
      PURPOSE: This example read layer info (stat, map & projection info).

 CALLING SYNTAX:
      layerinfo <inputfile name>

      e.g.
      layerinfo "d:/work/data/30meter.img"
******************************************************************************
*****************************************************************************/

#define EFIO_STDIO_PROTOTYPES_PASSTHROUGH // WILL ENABLE printf()

#include <stdlib.h>

/*
** TOOLKIT INCLUDES
*/
#include <eint.h> // TOOLKIT INITIALIZATION PACKAGE.
```

```
#include <eerr.h> // ERROR LOGGING AND REPORTING PACKAGE.
#include <esmg.h> // SESSION MANAGER API PACKAGE.
#include <emsc.h> // MISCELLANEOUS FUNCTIONS FOR COMMON OPERATIONS.
#include <estr.h> // STRING PACKAGE.
#include <egda.h> // DEFINE PIXEL TYPE
#include <eimg.h> // HIGH LEVEL API TO CREATE OR ACCESS IMG FILES


/*
** ERROR CHECKING MACROS.
*/
#define EFS0( msg ) EERR_FATAL_SET_0( __LINE__, msg )
#define EFS1( msg, arg ) EERR_FATAL_SET_1( __LINE__, msg, arg )

static int  rc = -1;


/*
** EXECUTION ENTRY POINT
*/
int main(int argc, char **argv)
{
      long  column, row;
      long  width, height;
      int   i;

      Estr_StringList   *           layernames = NULL;
      Eimg_LayerStack   *           layerstack = NULL;
      Esta_Statistics   *           stats = NULL;
      Eprj_MapInfo      *           mapinfo = NULL;
      Eprj_MapProjection      *     projectioninfo = NULL;
      Eprj_ProParameters      *     proParams;

      /*
      ** DECLARES, INITIALIZES ALL VARIABLES TO BE USED BY THE OTHER EERR
      **    MACROS.
      */
      EERR_INIT("layerinfo", &lclerr, lclerr);

      /*
      ** SETUP THE BASE APPLICATION ENVIRONMENT, THIS INCLUDES CONNECTION FOR
      **    SESSION MANAGER, ENVIRONMENT VARIABLES, REGISTER RASTER FROMAT DLLS, ETC...
      */
      esmg_ApplicationInit(NULL);

      /*
      ** INIT TOOLKIT.
      */
      (void) eint_InitToolkit( (Emsc_Opaque**)&lclerr );
      EERR_CHECK(lclerr, EFS0("ERROR eint_InitToolkit"));


      /*
      ** GET ALL LAYER NAMES
      */
      layernames = eimg_LayerGetNames(argv[1], eint_GetInit(), &lclerr);
      EERR_CHECK(lclerr, EFS0("ERROR eimg_LayerGetNames"));


      /*
      ** OPEN ALL LAYERS
```

```
	*/
	layerstack = eimg_LayerStackOpen(layernames, eint_GetInit(),
		&lclerr, EIMG_LAYER_OPTION_READONLY,
		EIMG_LAYER_OPTION_END);
	EERR_CHECK(lclerr, EFS0("ERROR eimg_LayerStackOpen"));


	/*
	** GET STATS, MAP & PROJECTION INFO FOR ALL LAYERS
	*/
	for (i=0; i<layernames->count; i ++)
	{
		printf("Layer: %s\n", layerstack->layers[i]->fullName);

		/*
		** Basic Statisitics
		*/
		stats = eimg_StatisticsRead( layerstack->layers[i],
			NULL, &lclerr);
		printf("\nThe basic Statistics: \n");
		printf("The minimum: %g\n",  (double)stats->minimum);
		printf("The maximum: %g\n",  (double)stats->maximum);
		printf("The mean: %g\n",     (double)stats->mean);
		printf("The median: %g\n",   (double)stats->median);
		printf("The stddev: %g\n",   (double)stats->stddev);

		/*
		**    Map Info
		*/
		mapinfo = eimg_LayerMapInfoGet(layerstack->layers[i], &lclerr);
		printf("\nThe Map Info: \n");
		printf("The Upper Left X: %g\n", mapinfo->upperLeftCenter->x);
		printf("The Upper Left Y: %g\n", mapinfo->upperLeftCenter->y);
		printf("The Lower Right X: %g\n", mapinfo->lowerRightCenter->x);
		printf("The Lower Right Y: %g\n", mapinfo->lowerRightCenter->y);
		printf("The Pixel Size X: %g\n", mapinfo->pixelSize->width);
		printf("The Pixel Size Y: %g\n", mapinfo->pixelSize->height);
		printf("The Unit: %s\n", mapinfo->units.data);

		/*
		**    Projection Info
		*/
		eimg_LayerMapProjectionRead(layerstack->layers[i], &projectioninfo, &lclerr);
		proParams = EPRJ_PROPARAMETERS_GET(projectioninfo);
		printf("\nThe Projection Info: \n");
		printf("The Projection Name: %s, Zone %d\n",
			proParams->proName.data,
			proParams->proZone);
		printf("The Spheroid Name: %s\n", proParams->proSpheroid->sphereName.data);
		printf("The Datum Name: %s\n", proParams->proName.data);
	}


	rc = 1;

cleanup:

	EERR_SHOW(lclerr, EERR_DEBUG);
	if (layerstack)
	{
		eimg_LayerStackClose(layerstack, &lclerr);
```

```
            EERR_DELETE( lclerr );
            layerstack = NULL;
      }
      if (stats)
      {
            esta_StatisticsDelete( stats, &lclerr);
            EERR_DELETE( lclerr );
            stats = NULL;
      }
      /*
      ** You don't need to free proParams, because it
      **    is only a pointer which point to part of the
      **    Eprj_MapProjection structure.
      **    Free the projectioninfo will be enough.
      */
      /*
      if (proParams)
      {
            eprj_ProParametersFree(&proParams);
            proParams = NULL;
      }
      */
      if (projectioninfo)
      {
            eprj_ProjectionFree( &projectioninfo);
            projectioninfo = NULL;
      }
      if (mapinfo)
      {
            eprj_MapInfoFree( &mapinfo );
            mapinfo = NULL;
      }
      if (layernames)
      {
            estr_StringListDelete( layernames, &lclerr);
            EERR_DELETE( lclerr );
            layernames = NULL;
      }

      /*
      ** return 0 when job finish successfully
      ** return -1 when failed.
      */
      return rc;
}
```

Code Explanation:

Reading Other Layer Information

The **eimg** package contains functions to read the non-image data contained within a layer; e.g. statistics, map info, etc. These functions are of the form **eimg_XxxxRead**, although the structures they return usually come from other packages.

The **esta** package is used to access statistical information. **eimg_StatisticsRead()** reads the image statistics from a layer and returns a pointer to an **Esta_Statistics** structure:

---

eimg_StatisitcsRead()

The prototype of this API is:

```
Esta_Statistics * eimg_StatisticsRead( Eimg_Layer        *layer,
      Esta_Statistics          *statInfo,
      Eerr_ErrorReport    **inerr)
```

The **eimg_StatisticsRead()** reads the image statistics from a layer and returns a pointer to an Esta_Statistics structure.

Esta_Statisitcs

The prototype of this structure is:

```
typedef struct {
    Esta_StatisticsValue minimum; /* Minimum value */
    Esta_StatisticsValue maximum; /* Maximum value */
    Esta_StatisticsValue mean;    /* Mean value */
    Esta_StatisticsValue median;  /* Median value */
    Esta_StatisticsValue mode;    /* Mode value */
    Esta_StatisticsValue stddev;  /* Standard deviation */
} Esta_Statistics;
```

This structure contains commonly used scalar statistics.

---

eimg_LayerMapInfoGet()

The prototype of this API is:

```
Eprj_MapInfo * eimg_LayerMapInfoGet( Eimg_Layer      *layer,
      Eerr_ErrorReport  **inerr)
```

This function reads the map info associated with the layer, and **Eprj_MapInfo** structure is returned.

eimg_LayerMapProjectionRead()

The prototype of this API is:

```
void eimg_LayerMapProjectionRead( Eimg_Layer         *layer,
Eprj_MapProjection **projectionP,
Eerr_ErrorReport   **inerr)
```

This function reads the map projection associated with the specified **Eimg_Layer**, this map projection describes the earth to map system transformation. The map projection associated with the layer is returned as an **Eprj_MapProjection** structure. The memory is allocated and returned.

The **eprj** package is the map and projection package. The **Eprj_MapInfo** structure is defined thusly:

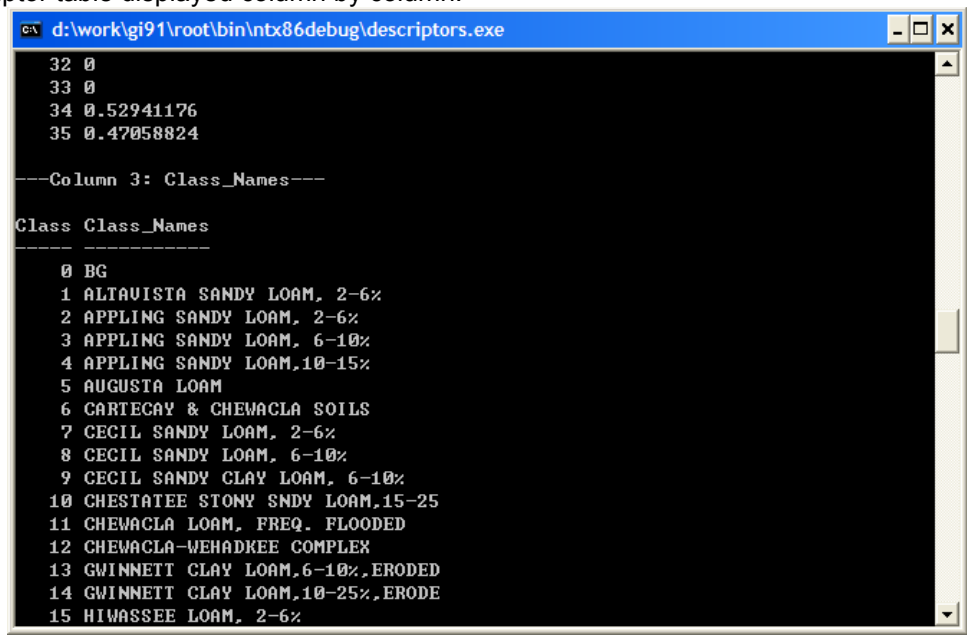
```
typedef struct
{
      Eprj_CharStrPtr proName;/* projection name */
      Eprj_Coordinate *upperLeftCenter;
      /* map coordinates of center of upper left pixel */
      Eprj_Coordinate *lowerRightCenter;
      /* map coordinates of center of lower right pixel */
      Eprj_Size *pixelSize; /* pixel size in map units */
      Eprj_CharStrPtr units; /* units of the map */
} Eprj_MapInfo;
```

The **Eprj_MapProjection** structure contains is an **Eprj_ProParameters** structure which stores projection parameters. The **Eprj_ProParameters** structure is defined as:

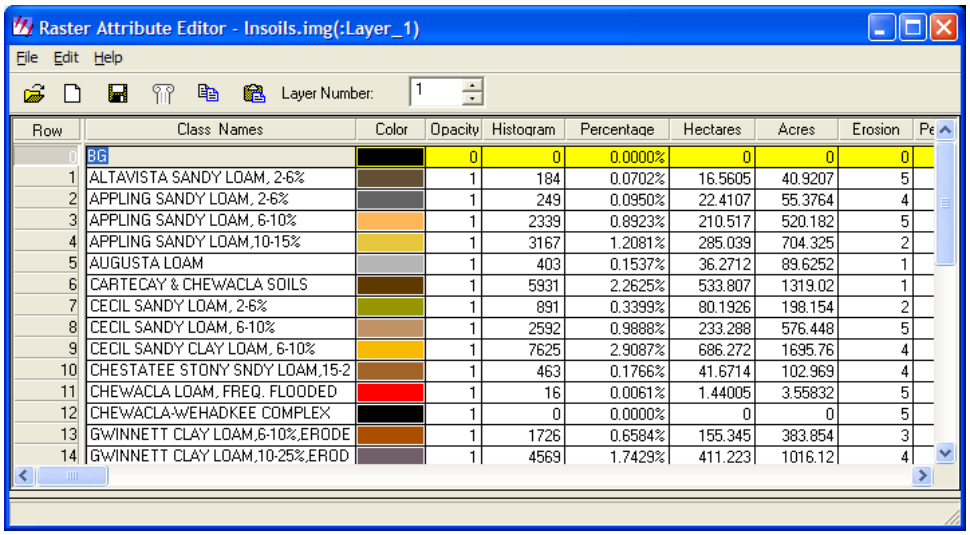
```
typedef struct
{
      Eprj_ProType proType;/* projection type */
      long proNumber;/* projection number for internal projections
                        */
      Eprj_CharStrPtr proExeName; /* projection executable name
                                     for external projections
                                     */
      Eprj_CharStrPtr proName; /* projection name */
      long proZone; /* projection zone (UTM, SP only) */
      Eprj_DblArrayPtr proParams; /* projection parameters array
                                      in the GCTP form */
      Eprj_Spheroid *proSpheroid;/* projection spheroid */
} Eprj_ProParameters;
```

E: Reading a Descriptor (Attribute) Table

In our next example (Sec5_03e), we will learn how to read descriptor table. The following show the descriptor table displayed column by column:



This figure shows the descriptor table from IMAGINE:



Row	Class Names	Color	Opacity	Histogram	Percentage	Hectares	Acres	Erosion	Pe
0	BG		0	0	0.0000%	0	0	0	
1	ALTAVISTA SANDY LOAM, 2-6%		1	184	0.0702%	16.5605	40.9207	5	
2	APPLING SANDY LOAM, 2-6%		1	249	0.0950%	22.4107	55.3764	4	
3	APPLING SANDY LOAM, 6-10%		1	2339	0.8923%	210.517	520.182	5	
4	APPLING SANDY LOAM,10-15%		1	3167	1.2081%	285.039	704.325	2	
5	AUGUSTA LOAM		1	403	0.1537%	36.2712	89.6252	1	
6	CARTECAY & CHEWACLA SOILS		1	5931	2.2625%	533.807	1319.02	1	
7	CECIL SANDY LOAM, 2-6%		1	891	0.3399%	80.1926	198.154	2	
8	CECIL SANDY LOAM, 6-10%		1	2592	0.9888%	233.288	576.448	5	
9	CECIL SANDY CLAY LOAM, 6-10%		1	7625	2.9087%	686.272	1695.76	4	
10	CHESTATEE STONY SNDY LOAM,15-2		1	463	0.1766%	41.6714	102.969	4	
11	CHEWACLA LOAM, FREQ. FLOODED		1	16	0.0061%	1.44005	3.55832	5	
12	CHEWACLA-WEHADKEE COMPLEX		1	0	0.0000%	0	0	5	
13	GWINNETT CLAY LOAM,6-10%,ERODE		1	1726	0.6584%	155.345	383.854	3	
14	GWINNETT CLAY LOAM,10-25%,EROD		1	4569	1.7429%	411.223	1016.12	4	

Code Snippet (Sec5_03e)

```
/*****************************************************************************
******************************************************************************
 JOB: descriptors
      PURPOSE: This example descriptor table.

 CALLING SYNTAX:
      descriptors <inputfile name>

      e.g.
      descriptors "d:/work/data/lnsoils.img"
******************************************************************************
*****************************************************************************/

#define EFIO_STDIO_PROTOTYPES_PASSTHROUGH // WILL ENABLE printf()

#include <stdlib.h>

/*
** TOOLKIT INCLUDES
*/
#include <eint.h> // TOOLKIT INITIALIZATION PACKAGE.
#include <eerr.h> // ERROR LOGGING AND REPORTING PACKAGE.
#include <esmg.h> // SESSION MANAGER API PACKAGE.
#include <emsc.h> // MISCELLANEOUS FUNCTIONS FOR COMMON OPERATIONS.
#include <estr.h> // STRING PACKAGE.
#include <egda.h> // DEFINE PIXEL TYPE
#include <eimg.h> // HIGH LEVEL API TO CREATE OR ACCESS IMG FILES


/*
** ERROR CHECKING MACROS.
*/
#define EFS0( msg ) EERR_FATAL_SET_0( __LINE__, msg )
#define EFS1( msg, arg ) EERR_FATAL_SET_1( __LINE__, msg, arg )

static int  rc = -1;


/*
** EXECUTION ENTRY POINT
*/
int main(int argc, char **argv)
{
      long  col, row;
      long  numrows, height;
      int   i;

      Estr_StringList   *          layernames = NULL;
      Eimg_Layer  *                layer = NULL;
      Esta_Histogram    *          histogram = NULL;

      Edsc_Table  *                table = NULL;
      Estr_StringList   *          columnnames = NULL;
      char *                       columnname = NULL;
```

```
Edsc_Column *                column = NULL;

Egda_PixelType               datatype;
Egda_Table *                 data = NULL;

char  *                      c = NULL;
/*
** DECLARES, INITIALIZES ALL VARIABLES TO BE USED BY THE OTHER EERR
**    MACROS.
*/
EERR_INIT("descriptors", &lclerr, lclerr);

/*
** SETUP THE BASE APPLICATION ENVIRONMENT, THIS INCLUDES CONNECTION FOR
**    SESSION MANAGER, ENVIRONMENT VARIABLES, REGISTER RASTER FROMAT DLLS, ETC...
*/
esmg_ApplicationInit(NULL);

/*
** INIT TOOLKIT.
*/
(void) eint_InitToolkit( (Emsc_Opaque**)&lclerr );
EERR_CHECK(lclerr, EFS0("ERROR eint_InitToolkit"));


/*
** GET ALL LAYER NAMES
*/
layernames = eimg_LayerGetNames(argv[1], eint_GetInit(), &lclerr);
EERR_CHECK(lclerr, EFS0("ERROR eimg_LayerGetNames"));


/*
** OPEN THE FIRST LAYER
*/
layer = eimg_LayerOpen(layernames->strings[0], eint_GetInit(),
      &lclerr, EIMG_LAYER_OPTION_READONLY,
      EIMG_LAYER_OPTION_END);
EERR_CHECK(lclerr, EFS0("ERROR eimg_LayerOpen"));


/*
** GET DESCRIPTOR TABLE FROM LAYER
*/
table = layer->table;

/*
** GET LIST OF COLUMN NAMES FROM TABLE
*/
columnnames = edsc_TableListColumns(table, &lclerr);
for (i =0; i< columnnames->count; i++)
{
      columnname = columnnames->strings[i];
      printf("Column %d: %s\n", i, columnname);
}

/*
** GET CONTENT OF TABLE
*/
for (i =0; i< columnnames->count; i++)
{
```

```
columnname = columnnames->strings[i];
printf("\n---Column %d: %s---\n", i, columnname);

/*
** OPEN COLUMN
*/
column = edsc_ColumnOpen( table, columnname, &lclerr);

/*
** GET COLUMN DATA TYPE
*/
switch (column->dataType)
{
      case EDSC_COLUMN_INTEGER:
            datatype = EGDA_TYPE_S32;
            break;
      case EDSC_COLUMN_REAL:
            datatype = EGDA_TYPE_F64;
            break;
      case EDSC_COLUMN_COMPLEX:
            datatype = EGDA_TYPE_C128;
            break;
      case EDSC_COLUMN_STRING:
            datatype = EGDA_TYPE_STRING;
            break;
}

/*
** CREATE BASE DATA TO READ INTO (A VECTOR TABLE)
*/
data = egda_TableCreate ( column->numRows, datatype, NULL, &lclerr);
edsc_ColumnRead ( column,
      0L, //Specifies the row within column from which to begin reading
      column->numRows, //Specifies the total number of rows to read.
      data, //Specifies an in-memory table into which the data may be read.
      &lclerr);

/*
** PRINT DATA
*/
printf ("\nClass %s\n", columnname);
printf ("----- ");
for (c = columnname; *c; c++) printf ("-");
printf ("\n");

for (row = 0; row < column->numRows; row++)
{
      printf ("%5d ", row);
      switch (column->dataType)
      {
            case EDSC_COLUMN_INTEGER:
                  printf ("%d\n", EGDA_S32TABLE (data, row));
                  break;
            case EDSC_COLUMN_REAL:
                  printf ("%.8g\n",EGDA_F64TABLE (data, row));
                  break;
            case EDSC_COLUMN_COMPLEX:
                  printf ("(%.8g, %.8g)\n",
                        EGDA_C128TABLE (data, row).real,
                        EGDA_C128TABLE (data, row).imag);
                  break;
```

```
                        case EDSC_COLUMN_STRING:
                              printf ("%s\n",
                              EGDA_StringTABLE (data, row));
                        break;
                  }
            }

            edsc_ColumnClose(column, &lclerr);
            EERR_DELETE( lclerr );
            column = NULL;
      }

      rc = 1;

cleanup:

      EERR_SHOW(lclerr, EERR_DEBUG);
      if (layer)
      {
            eimg_LayerClose(layer, &lclerr);
            EERR_DELETE( lclerr );
            layer = NULL;
      }
      if (column)
      {
            edsc_ColumnClose(column, &lclerr);
            EERR_DELETE( lclerr );
            column = NULL;
      }
      if (data)
      {
            egda_TableDelete(data, &lclerr);
            EERR_DELETE( lclerr );
            data = NULL;
      }
      if (columnnames)
      {
            estr_StringListDelete( columnnames, &lclerr);
            EERR_DELETE( lclerr );
            columnnames = NULL;
      }
      if (layernames)
      {
            estr_StringListDelete( layernames, &lclerr);
            EERR_DELETE( lclerr );
            layernames = NULL;
      }


      /*
      ** return 0 when job finish successfully
      ** return -1 when failed.
      */
      return rc;
}
```

Code Explanation:

Access Descriptor Table

A Descriptor Table is a way of representing attribute or descriptor information associated with pixel values. Descriptor tables are usually thought of in terms of thematic files; For example, in Insoils.img, each pixel value represents a soil type rather than a measured value. Howerver, athematic files have descriptor tables too, normally just to hold histogram information.

The **edsc** package is used for description table access. The **Edsc_Table** structure is used to represent a 2D array of data in tabular form. Each row in the table corresponds to a pixel value or range of values, and each column corresponds to an attribute.

Edsc_Table

The prototype of this structure is:

```
typedef struct {
      long numRows;/* Height of the table */
      Edsc_BinFunction *binFunction;/* Pointer to bin function
      structure */
      ...
} Edsc_Table;
```

An IMAGINE layer has one **Edsc_Table** structure; there is a table entry in the **Eimg_Layer** structure which points to the table.

Each column in a table is referred to by name; a list of all the columns for a table may be found using **edsc_TableListColumns**:

---

edsc_TableListColumns()

The prototype of this API is:

```
Estr_StringList *edsc_TableListColumns( Edsc_Table *table,
      Eerr_ErrorReport **inerrorreport );
```

---

edsc_ColumnOpen()

Columns must first be opened (or created) before they are used:

The prototype of this API is:

```
Edsc_Column *edsc_ColumnOpen( Edsc_Table *table,
      char *columnname,
      Eerr_ErrorReport **inerrorreport, ...);
```

A pointer to an **Edsc_Column** structure is returned:

Edsc_Column

```
typedef struct {
      long numRows; /* Height of the column */
      ...
      Edsc_ColumnType dataType; /* Data type of this column */
      long maxNumChars;/* Max string length (string data only) */
      ...
      Edsc_Table *table;/* Pointer to table structure under
      which this column belongs */
      ...
} Edsc_Column;
```

Edsc_ColumnType

The **Edsc_ColumnType** specifies the kind of data a table column stores:
The prototype of this structure is:

```
typedef enum {
      EDSC_COLUMN_INVALID = -1,
      EDSC_COLUMN_INTEGER = 0,/* Column data are integer-valued */
      EDSC_COLUMN_REAL = 1, /* Column data are real-valued */
      EDSC_COLUMN_COMPLEX = 2,/* Column data are complex-valued */
      EDSC_COLUMN_STRING = 3 /* Column data are character strings */
} Edsc_ColumnType;
```

To read the column data itself, use **edsc_ColumnRead()**. It places column data into an **Egda_Table** structure, which is typedef'd to an **Egda_BaseData** structure. An **Egda_Table** is a 1-D array. It can be created using **egda_TableCreate**:

egda_TableCreate()

The prototype of this API is:

```
Egda_Table *egda_TableCreate( long numrows,
      Egda_PixelType datatype,
      Egda_Byte *dataptr, Eerr_ErrorReport **err );
```

This function creates an **Egda_Table** structure with **numrows** rows, with **datatype** pixeltype.
If **dataptr** is NULL, it will allocate space for the data array; otherwise **dataptr** is used for the data array.

edsc_ColumnRead() is defined:

edsc_ColumnRead()

```
void edsc_ColumnRead( Edsc_Column *column, long startelement,
long numelements, Egda_BaseData *columndata,
Eerr_ErrorReport **inerrorreport );
```

This function reads numelements from the **column**, starting with **startelement**. The data are stored in **columndata**. The data are automatically converted to the datatype of **columndata**.

Class Notes:

Exercise 4: An Advanced Toolkit JOB (ConvertMDF)

Exercise Objective:

After exercises 1, 2, and 3, you will be familiar with the basics of how to program with the **eimg** package. In the remaining exercises, 4, 5, 6, and 7, we will introduce how to create an advanced Toolkit JOB, "**Convertmdf**", to convert a known data format (***.mdf**) into an IMAGINE native format (***.img**).

During this exercise we will use the **efio** package to read a ***.mdf** file, and write its contents to an ***.img** file. You will learn the basic concepts of image type and pixel depth as well.

Packages used:

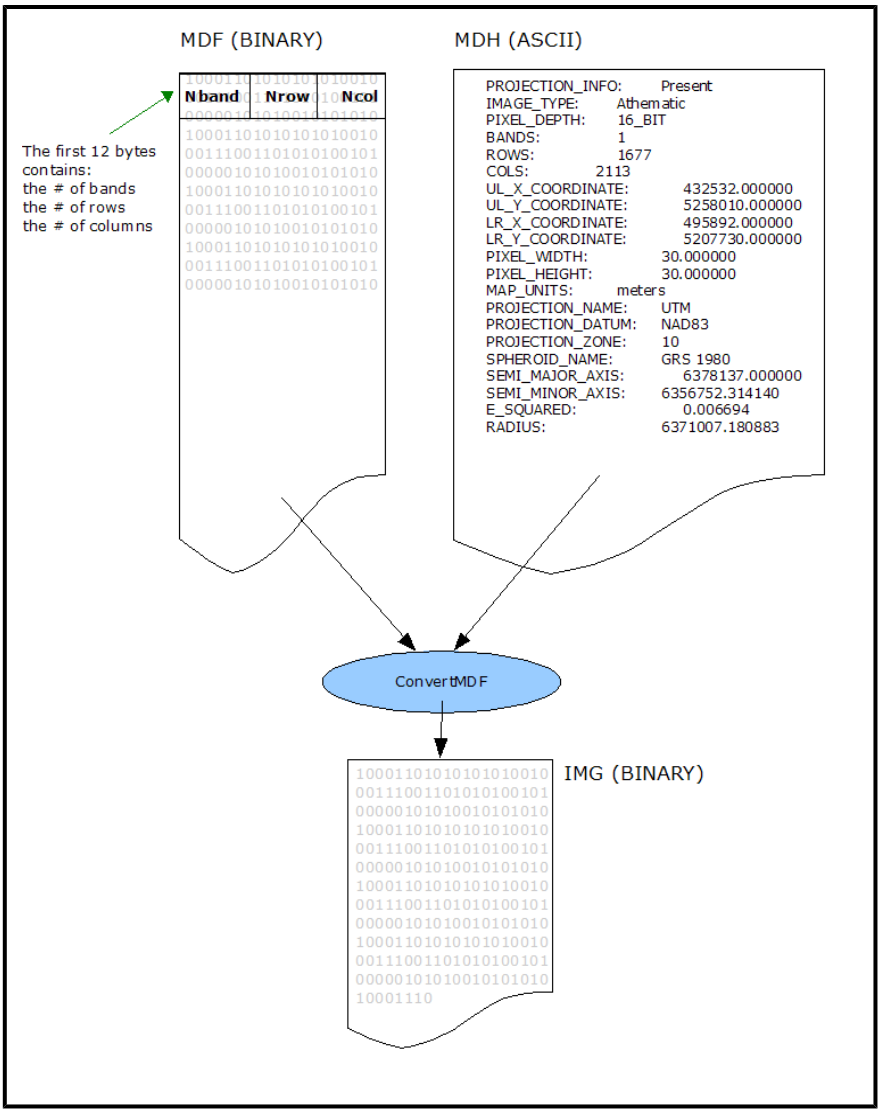
eint
eerr
emsc
esmg

Overview

We will approach this section using a scenario where we have been assigned a project by our boss. This project involves converting a known, but currently unsupported, data format (**M**y **D**ata **F**ormat [.mdf]) into IMAGINE's native .img format. The files to be converted are generic binary with a 12-byte header containing the number of bands, rows, and columns in the image. This information is extremely important to us.

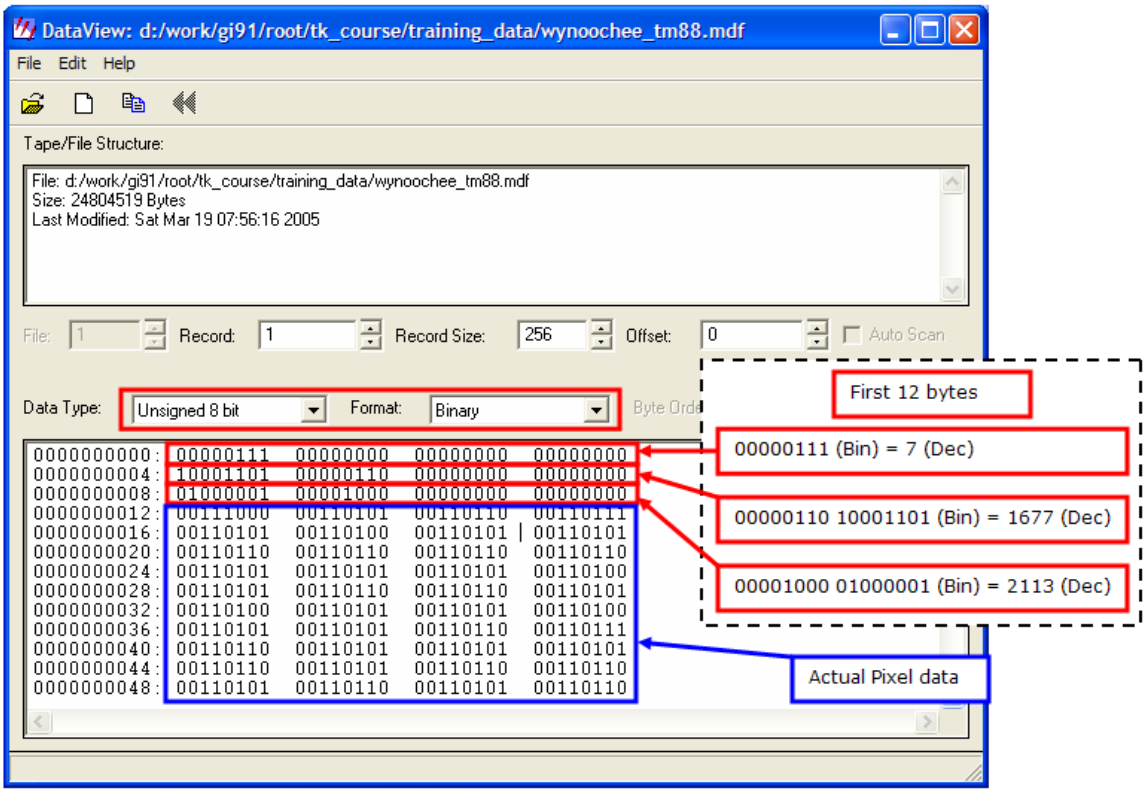
There is other information available in an auxiliary header file (.mdh). Together, these will allow us to come up with a way to read that information. Once we can read the generic file, we will want to write this information directly to an .img file. The concern here is with regard to that image, the auxiliary header file also contains projection and map information. So we must also store that information within the .img files that we convert.

The following figure shows the structure of MDF and MDH.

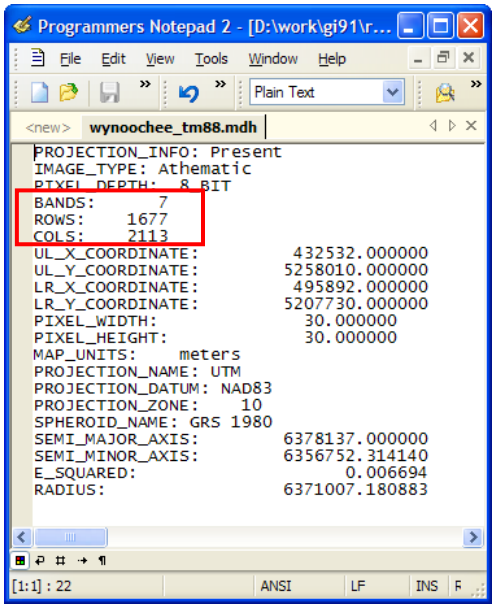


A Close look at MDF

A MDF (***.mdf**) file consist of a 12 bytes header and generic binary in BSQ format. We have an example MDF file called "**wynoochee_tm88.mdf**" in your training data folder.
You can use the IMAGINE dataview tool to look at the actual binary data (IMAGINE menu->Tools->View Binary Data). The following figure shows the details about the first 12 bytes header, and the actual image pixel data.



The 12 bytes header information from "**wynoochee_tm88.mdf**" should match the "**BANDS**", "**ROWS**", and "**COLS**" in "**wynoochee_tm88.mdh**" header file. Below is what the "**wynoochee_tm88.mdh**" looks like:



What is the image type?

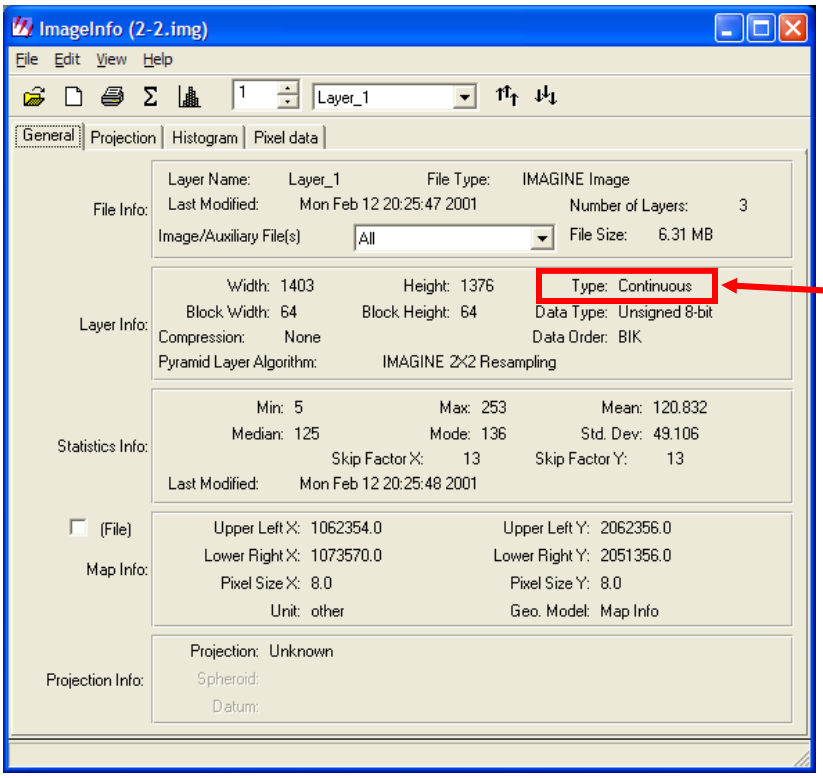
The image type in IMAGINE must be either "**ATHEMATIC**" or "**THEMATIC**" (in this class we will not discuss the FFT image type (EIMG_REALFFT_LAYER)). Both of these image type look the same from the "Binary data" point of view. The difference comes in the way you interpret the pixel value. In an "**ATHEMATIC**" image, the digital value **0** may represent the reflectance value, while the **0** in a "**THEMATIC**" image may represent the **class 0** (e.g water). The output image from un-supervised classification will always be "**THEMATIC**".

"**ATHEMATIC**": means **CONTINUOUS** data.
"**THEMATIC**": means **CATEGORICAL** data, usually the classification result.

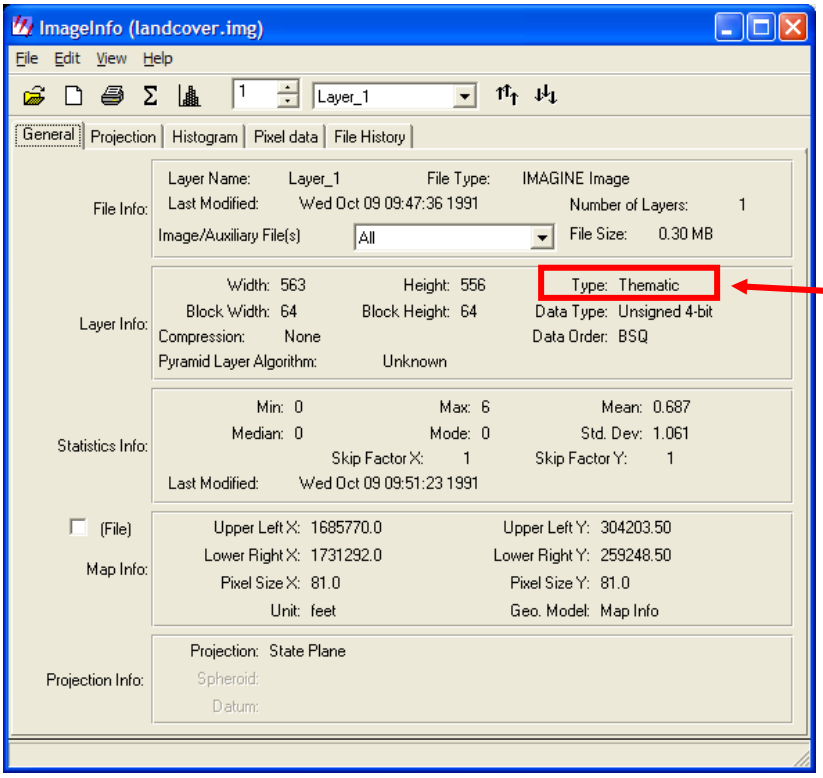
The layer type is governed by the **eimg** package:

```
typedef enum {
    EIMG_THEMATIC_LAYER = 0,  /* Data is thematic (i.e., each pixel
                         ** value is the index of a class)
                         */
    EIMG_ATHEMATIC_LAYER,     /* Data is a measurement of some sort */
    EIMG_REALFFT_LAYER        /* Data is a packed FFT of real-valued data*/
} Eimg_LayerType;
```

You can also find the image type from **ImageInfo** dialog; the following figures show where to look at the Image type:


ImageInfo (2-2.img)
File Edit View Help
Layer_1
General Projection Histogram Pixel data
File Info:
Layer Name: Layer_1 File Type: IMAGINE Image
Last Modified: Mon Feb 12 20:25:47 2001 Number of Layers: 3
Image/Auxiliary File(s) All File Size: 6.31 MB
Layer Info:
Width: 1403 Height: 1376 Type: Continuous
Block Width: 64 Block Height: 64 Data Type: Unsigned 8-bit
Compression: None Data Order: BIK
Pyramid Layer Algorithm: IMAGINE 2X2 Resampling
Statistics Info:
Min: 5 Max: 253 Mean: 120.832
Median: 125 Mode: 136 Std. Dev: 49.106
Skip Factor X: 13 Skip Factor Y: 13
Last Modified: Mon Feb 12 20:25:48 2001
(File)
Map Info:
Upper Left X: 1062354.0 Upper Left Y: 2062356.0
Lower Right X: 1073570.0 Lower Right Y: 2051356.0
Pixel Size X: 8.0 Pixel Size Y: 8.0
Unit: other Geo. Model: Map Info
Projection Info:
Projection: Unknown
Spheroid:
Datum:

The “Continuous” here represent the Athematic layer.


ImageInfo (landcover.img)
File Edit View Help
Layer_1
General Projection Histogram Pixel data File History
File Info:
Layer Name: Layer_1 File Type: IMAGINE Image
Last Modified: Wed Oct 09 09:47:36 1991 Number of Layers: 1
Image/Auxiliary File(s) All File Size: 0.30 MB
Layer Info:
Width: 563 Height: 556 Type: Thematic
Block Width: 64 Block Height: 64 Data Type: Unsigned 4-bit
Compression: None Data Order: BSQ
Pyramid Layer Algorithm: Unknown
Statistics Info:
Min: 0 Max: 6 Mean: 0.687
Median: 0 Mode: 0 Std. Dev: 1.061
Skip Factor X: 1 Skip Factor Y: 1
Last Modified: Wed Oct 09 09:51:23 1991
(File)
Map Info:
Upper Left X: 1685770.0 Upper Left Y: 304203.50
Lower Right X: 1731292.0 Lower Right Y: 259248.50
Pixel Size X: 81.0 Pixel Size Y: 81.0
Unit: feet Geo. Model: Map Info
Projection Info:
Projection: State Plane
Spheroid:
Datum:

The “Thematic” here represent the Thematic layer.

What are the Pixel depths?

The “PIXEL_DEPTH: 8_BIT” in the “**wynoochee_tm88.mdh**” file defines the Pixel Depth of the image.

What is the Pixel Depth?

Pixel Depth is the number of bits required to store all of the data file values in a file e.g. data with a pixel depth of 8, or unsigned 8-bit data, have 256 values (28 = 256), ranging from 0 to 255.

Remotely sensed imagery usually comes in unsigned 8- or 16-bit binary data, although more are usually supported. It is important for the programmer to take into account the different “pixel depths” that a user may want to apply in his/her program.

Before we tackle any data processing using the Toolkit, we need to be aware of the data type with which we will interact. By adding an option to our command line, we can specify the pixel type of our input image, and determine how many bits/bytes will equal one Digital Number in our image.

We could also specify an output image type, but in this case, we will let the output pixel depth equal the input. If we were to perform some operation on the data, we would need to ensure that the output pixel type can hold the actual output values.

The pixel type is governed by the **egda** package:

```
typedef enum {
   EGDA_TYPE_INVALID = -1,
   EGDA_TYPE_U1=0,  /* Unsigned one bit [0..1] */
   EGDA_TYPE_U2,    /* Unsigned two bit [0..3] */
   EGDA_TYPE_U4,    /* Unsigned four bit [0..15] */
   EGDA_TYPE_U8,    /* Unsigned eight bit [0..255] */
   EGDA_TYPE_S8,    /* Signed eight bit [-128..127] */
   EGDA_TYPE_U16,   /* Unsigned sixteen bit [0..65536] */
   EGDA_TYPE_S16,   /* Signed sixteen bit [-32768..32767] */
   EGDA_TYPE_U32,   /* Unsigned thirty two bits [0..4294967295] */
   EGDA_TYPE_S32,   /* Signed thirty two bits [-2147483648..2147483647] */
   EGDA_TYPE_F32,   /* Floating point data */
   EGDA_TYPE_F64,   /* Double Precision data */
   EGDA_TYPE_C64,   /* Complex data */
   EGDA_TYPE_C128,  /* Double Complex data */
   EGDA_TYPE_STRING /* String data */
 } Egda_PixelType;
```

We should now be able to specify one of the enumerated data types above as our input pixel type, and then make use of this throughout the program.

It is easy to use Egda_PixelType instead of using the actual C data type. Here is the actual data type we use inside IMAGINE (“**egda.h**”):

```
typedef Egda_Byte        Egda_U1;
typedef Egda_Byte        Egda_U2;
typedef Egda_Byte        Egda_U4;
typedef unsigned char    Egda_U8;
typedef char             Egda_S8;
typedef unsigned short   Egda_U16;
typedef short            Egda_S16;
#if ESYS_OS == ESYS_ULTRIX || ESYS_OS == ESYS_NT
typedef unsigned long    Egda_U32;
typedef long             Egda_S32;
```

```
#else
typedef unsigned int     Egda_U32;
typedef int              Egda_S32;
#endif
typedef float            Egda_F32;
typedef double                Egda_F64;
typedef Egda_Complex          Egda_C64;
typedef Egda_DoubleComplex    Egda_C128;
typedef Etxt_Text             Egda_String;
#if ESYS_OS == ESYS_NT
typedef unsigned __int64      Egda_U64;
typedef __int64 Egda_S64;
#elif ESYS_OS == ESYS_SOLARIS
typedef unsigned long long    Egda_U64;
typedef long long Egda_S64;
#elif ESYS_OS == ESYS_IRIX || ESYS_OS == ESYS_AIX
#include <unistd.h>
typedef uint64_t Egda_U64;
typedef int64_t Egda_S64;
#else
typedef unsigned long         Egda_U64;
#endif
```

Design the Command line

Since this "**Convertmdf**" program is an IMAGINE JOB, the command line should contain the following arguments:

1. Input MDF file name (required)
2. Output IMG file name (required)
3. support for selecting pixel depth (required)
4. Support for selecting image type (required)
5. support for reading Projection info from MDH header file (optional)
6. support for metering (optional)

The pixel depth argument is required, because you can not read the correct pixel value if you don't know the number of bits per pixel.

The image type argument is also required, because an IMAGINE (*.img) file must be either "**ATHEMATIC**" or "**THEMATIC**".

The reading header argument is optional since an IMAGINE file can exist without the projection info.

Here is the **Earg_Cmd** structure based on our design:

```
/*
** COMMAND ARGUMENT PROTOTYPE.
*/
Earg_Cmd command[] =
{
     set_input,        "-in[put] %s",              "" NULL,
     set_output,       "-out[put] %s",             "", NULL,
     set_pixeldepth,   "-p[ixel[depth]] %s",       "", NULL,
     set_imagetype,    "-t[ype] %s",               "", NULL,
     set_header,       "-h[eader] [%d]",           "", NULL,
     set_meter,        "-m[eter] [%d]",            "", NULL,
     jobMain,          "convertMDF",               "", NULL,
     EARG_END

};
```

The example above shows the structure of a "Command Line Argument'. The first column is the function to be executed (i.e., **set_input**). The second column is the prototype of the command line argument (i.e., "**-in[put] %s**"). The third column contains the two arguments ("**",** NULL) are description and error functions, which are not used.

Some Details

The pixel depth (either u16 or u8) information from the "***.mdh**" header file is redundant, because you can always use the following equation to calculate the pixel depth:

PixelDepth (bytes per pixel) = [*ImageSize* (in byptes) – 12] / (*NBand* * *NRow* * *NCol*)

For this class and during these exercises redundancy will be kept.

Note: *What happen if you don't provide the –p, -t?*
The pixeldepth and imagetype are enum type; they will always get the default value (0). they will be initialized by default as:
pixeltype = **EGDA_TYPE_U1**, imagetype = **EIMG_THEMATIC_LAYER**

Note: *Can I remove quote from "u16"?*
Yes, you can remove the quote if the is no white space or special characters (i.e., -) in the argument. The following arguments are good.
–p u16 *or* ***-p "u16"***
IMAGINE command line will identify the u16 as characters automatically.

The Processing Logic

Since this exercise will cover many steps involving reading and writing image data, it is helpful to introduce the processing logic before going to the code.

The program reads binary data from "***.mdf**" files, and copies it to the img file. All of the information required to read this data type is listed below:

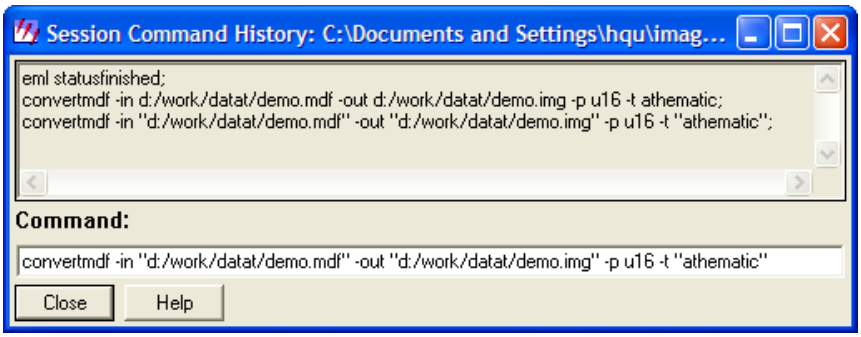
- Data (pixel) type (Must be provided before running this program)
- Number of bands (in 12 bytes header)
- Number of rows (in 12 bytes header)
- Number of columns (in 12 bytes header)

Below is the "raster processing logic" used in our program:

01. Open the mdf file.
02. Read the 12-byte header to get the bands, rows, and columns.
03. Create a buffer to hold exactly one row of data.
04. Create a layer to hold the one band of data.
05. Read one row of data into buffer.
06. Write buffer to layer.
07. Repeat steps 5 & 6 until the entire band has been written to layer.
08. Close layer and repeat steps 4 through 8 until entire image has been written.
09. Free buffer.
10. Close .mdf file.

How to run the example program

After you compile our example (Sec5_04), you can type the following command in the IMAGINE Command line to run the example:


Session Command History: C:\Documents and Settings\hqu\imag...
eml statusfinished;
convertmdf -in d:/work/datat/demo.mdf -out d:/work/datat/demo.img -p u16 -t athematic;
convertmdf -in "d:/work/datat/demo.mdf" -out "d:/work/datat/demo.img" -p u16 -t "athematic";
Command:
convertmdf -in "d:/work/datat/demo.mdf" -out "d:/work/datat/demo.img" -p u16 -t "athematic"
Close
Help

```
convertmdf –in “d:/work/data/demo.mdf” –out “d:/work/data/damo.img” –p u16 –t “athematic”;
```

Or, you can use a “command argument” in Microsoft Visual Studio as we discussed in previous exercise.

Code Snippet (Sec5_04): Convert MDF to IMG

```
/****************************************************************************
** JOB TEMPLATE
****************************************************************************/

/*
** TOOLKIT INCLUDES
*/
#include <eerr.h> // ERROR LOGGING AND REPORTING PACKAGE.
#include <eint.h> // TOOLKIT INITIALIZATION PACKAGE.
#include <esmg.h> // SESSION MANAGER API PACKAGE.
#include <emsc.h> // MISCELLANEOUS FUNCTIONS FOR COMMON OPERATIONS.
#include <earg.h> // ARGUMENT PARSING PACKAGE.
#include <estr.h> // STRING PACKAGE.

#include <egda.h> // DEFINE PIXEL TYPE
#include <efio.h> // LOW LEVEL FILE I/O (BINARY)
#include <eimg.h> // HIGH LEVEL API TO CREATE OR ACCESS IMG FILES
#include <emet.h> // FOR METERING SUPPORT
#include <efnp.h> // FOR SPLIT THE FILE PATH STRING
#include <time.h>

/*
** ERROR CHECKING MACROS.
*/
#define EFS0( msg ) EERR_FATAL_SET_0( __LINE__, msg )
#define EFS1( msg, arg ) EERR_FATAL_SET_1( __LINE__, msg, arg )


/*
** Earg DEPENDENT GLOBAL FUNCTIONS DECLARATION.
*/
static void jobMain(int, char **);
```

```
static void set_input(int, char **);
static void set_output(int, char **);
static void set_pixeldepth(int, char **);
static void set_imagetype(int, char **);
static void set_header(int, char **);
static void set_meter(int, char **);


/*
** OTHER FUNCTION
*/
static void ReadHeader(char *infile, char *outfile,
                            Eerr_ErrorReport **outerr);


/*
** COMMAND ARGUMENT PROTOTYPE.
*/
Earg_Cmd command[] =
{
            set_input,              "-in[put] %s",              "", NULL,
            set_output,             "-out[put] %s",             "", NULL,
            set_pixeldepth,         "-p[ixel[depth]] %s",       "", NULL,
            set_imagetype,          "-t[ype] %s",               "", NULL,
            set_header,             "-h[eader] [%d]",           "", NULL,
            set_meter,              "-m[eter] [%d]",            "",   NULL,
            jobMain,                "convertMDF",               "", NULL,
            EARG_END
};


/*
** Earg DEPENDENT GLOBAL VARIABLES FOR INPUT ARGUMENT.
*/
static char *               input = NULL;
static char *               output      = NULL;
static Egda_PixelType       pixeltype;  // EGDA_TYPE_U1 (BY DEFAULT)
static Eimg_LayerType       imagetype;  // EIMG_THEMATIC_LAYER (BY DEFAULT)
static Emet_MeterInfo *     meter = NULL;
static Emsc_Boolean         headerflag;
static int                  rc = -1;


/*
** EXECUTION ENTRY POINT
*/
int main(int argc, char **argv)
{
      /*
      ** DECLARES, INITIALIZES ALL VARIABLES TO BE USED BY THE OTHER EERR
      **    MACROS.
      */
      EERR_INIT("convertMDF", &lclerr, lclerr);

      /*
      ** INIT TOOLKIT.
      */
      (void) eint_InitToolkit( (Emsc_Opaque**)&lclerr );
      EERR_CHECK(lclerr, EFS0("ERROR eint_InitToolkit"));

      /*
```

```
	** REGISTER WITH THE SESSION MANAGER AS A JOB.
	*/
	esmg_JobInit("convertMDF", &lclerr);
	EERR_CHECK(lclerr, EFS0("Error esmg_JobInit"));

	/*
	** PARSE THE COMMAND LINE BASED ON THE PROTOTYPE.
	*/
	earg_DoArgs(command, argc, argv, &lclerr);

	/*
	** ANNOUNCE THAT THE JOB IS DONE.
	*/
	esmg_JobEnd(&lclerr);
	EERR_CHECK(lclerr, EFS0("Error esmg_JobEnd"));

cleanup:
	EERR_SHOW(lclerr, EERR_DEBUG);

	/*
	** return 0 when job finish successfully
	** return -1 when failed.
	*/
	return rc;
}


/*
** Earg DEPENDENT FUNCTION - INPUT
*/
static void set_input(int argc, char **argv)
{
	input = estr_Duplicate(argv[1]);   // DUPLICATE STRING.
	return;
}


/*
** Earg DEPENDENT FUNCTION - OUTPUT
*/
static void set_output(int argc, char **argv)
{
	output = estr_Duplicate(argv[1]);  // DUPLICATE STRING.
	return;
}


/*
** Earg DEPENDENT FUNCTION - PIXEL DEPTH
*/
static void set_pixeldepth(int argc, char **argv)
{
	if (argc == 1)
		pixeltype = EGDA_TYPE_U8; // DEFAULT: UNSIGNED 8 BITS
	else
	{
		if (estr_Eqic(argv[1], "u8"))  // COMPARE STRING, CASE INSENSITIVE.
			pixeltype = EGDA_TYPE_U8;
		else if (estr_Eqic(argv[1], "u16"))
			pixeltype = EGDA_TYPE_U16;
		else
```

```
                pixeltype = EGDA_TYPE_U8;
        }
        return;
}


/*
** Earg DEPENDENT FUNCTION - IMAGE TYPE
*/
static void set_imagetype(int argc, char **argv)
{
        if (argc == 1)
                imagetype = EIMG_ATHEMATIC_LAYER; //DEFAULT LAYER TYPE = ATHEMATIC
        else
        {
                if (estr_Eqic(argv[1], "thematic"))
                        imagetype = EIMG_THEMATIC_LAYER;
                else if (estr_Eqic(argv[1], "athematic"))
                        imagetype = EIMG_ATHEMATIC_LAYER;
                else
                        imagetype = EIMG_ATHEMATIC_LAYER;
        }
        return;
}


/*
** Earg DEPENDENT FUNCTION - METER
*/
static void set_meter(int argc, char **argv)
{
        return;
}


/*
** Earg DEPENDENT FUNCTION - HEADER
*/
static void set_header(int argc, char **argv)
{
        return;
}


/*
** Earg DEPENDENT FUNCTION - THE CORE PROCESS ENTRY POINT.
** The heart of the processing !
*/
static void jobMain(int argc, char **argv)
{
        Efio_Fd                         handle = NULL;   //INIT FILE DESCRIPTOR
        Eimg_PixelRect                  *pixelRect = NULL; //A buffer structure
        Eimg_Layer                      *layer= NULL;
        long                            numbands, numrows, numcols;
        long                            bytesperpixel, i, j;
        char                            *layername = NULL;

        EERR_INIT("jobMain", &lclerr, lclerr);

        /*
        ** CHECK INPUT, OUTPUT (REQUIRED)
```

```
*/
EERR_CHECK(!input, EFS0("Error: INPUT FILENAME DOESN'T EXIST."));
EERR_CHECK(!output, EFS0("Error: OUTPUT FILENAME DOESN'T EXIST."));


/*
** READ FIRST 12 BYPEs FROM MDF BINARY
*/
handle = efio_Open(input, "rb", &lclerr, NULL);
EERR_CHECK(lclerr, EFS0("Error opening generic file!"));

efio_ReadSeq (handle, (void*) &numbands, sizeof(long), &lclerr);
// LONG = 32 BITs = 4 BYTEs
EERR_CHECK(lclerr, EFS0("Error getting # of bands from file!"));
// READ BINARY DATA BIT BY BIT

efio_ReadSeq (handle, (void*) &numrows, sizeof(long), &lclerr);
EERR_CHECK(lclerr, EFS0("Error getting # of rows from file!"));

efio_ReadSeq (handle, (void*) &numcols, sizeof(long), &lclerr);
EERR_CHECK(lclerr, EFS0("Error getting # of columns from file!"));

/*
** CREATE AN EMPTY ROW BUFFER
*/
pixelRect = eimg_PixelRectCreate (numcols, 1, pixeltype, &lclerr);
EERR_CHECK(lclerr, EFS0("Error eimg_PixelRectCreate"));

if (pixeltype == EGDA_TYPE_U16) bytesperpixel = 2;
else bytesperpixel = 1;

if ( efio_FileExists(output, &lclerr) )
      // MAKE SURE THE OUTPUT IMG DOESN'T EXIST
{
      efio_FileUnlink(output, &lclerr); // DELETE IF EXIST
      EERR_CHECK(lclerr, EFS0("Error efio_FileUnlink"));
}

/*
** CREATE IMG FILE LAYER BY LAYER
**    Since MDF is BSQ format
*/
for (i = 1; i <= numbands; i++)
{
      layername = estr_Sprintf(NULL, "%s%s%d%s", &lclerr, output,
            "(:Band_", i, ")" );
      EERR_CHECK(lclerr, EFS0("Error creating the layer names!"));

      layer = eimg_LayerCreate (layername, imagetype, pixeltype,
            numcols, numrows,
            eint_GetInit(), &lclerr,
            EIMG_LAYER_OPTION_COMPUTE_STATS_ON_CLOSE,
            EIMG_LAYER_OPTION_END);
      EERR_CHECK(lclerr, EFS0("Error creating the layer!"));

      // READ ONE ROW AT ONE TIME
      for (j=0; j<numrows; j++)
      {
            //READ FROM MDF BINARY
            efio_ReadSeq (handle, pixelRect->data, (bytesperpixel*numcols),
                  &lclerr);
```

```
                EERR_CHECK(lclerr, EFS0("Error reading bytes file!"));

                //WRITE TO IMG
                eimg_LayerWrite (layer, 0, j, numcols, 1, pixelRect, &lclerr);
                EERR_CHECK(lclerr, EFS0("Error writing buffer to IMG layer!"));
          }
          eimg_LayerClose (layer, &lclerr);
          EERR_CHECK(lclerr, EFS0("Error closing active layer!"));
          layer = NULL;

     }

     /*
     ** MARK SUCCESSFUL FINISH!!
     */
     rc = 0 ;

cleanup:

     EERR_SHOW(lclerr, EERR_DEBUG);

     if ( pixelRect )
     {
          eimg_PixelRectDelete(pixelRect, &lclerr);
          EERR_DELETE(lclerr);
          pixelRect = NULL;
     }

     if (handle)
     {
          efio_Close (handle, &lclerr);
          EERR_DELETE(lclerr);
          handle = NULL;
     }

     if ( layer )
     {
          eimg_LayerClose (layer, &lclerr);
          EERR_DELETE(lclerr);
          layer = NULL;
     }


     return;
}
```

Code Explanation:

The efio package

This Low Level File I/O (**efio**) package provides functions for creating, reading, writing, locating, and finding information about files and directories. Many of these functions are simply wrappers for existing POSIX and ANSI C functions. The wrapper allows for expansion of environment variables in file names and directory paths, as well as the translation of the standard '**errno**' variable into an error report consistent with the eerr package. Other functions allow temporary file names to be generated and for a directory path to be searched while attempting to locate a particular file. The package also allows efficient I/O that is portable across platforms.

---

efio_open()

The prototype of this API is:

```
Efio_Fd efio_Open (Etxt_CText inpath, Etxt_CText mode, Eerr_ErrorReport
**errptr,...)
```

efio_Open() is equivalent to the C **fopen()** function. It is provided to guarantee portability across machines.
inpath is the string of input filename.
mode is the mode for opening file, equivalent to the mode in C fopen().

r: Open a file for reading (open as text file)
rb: Open a file for reading (open as binary file)
w: Create an empty file for writing (write as text file, overwrite if file existing).
wb: Create an empty file for writing (write as binary file, overwrite if file existing).

errptr is the error report. This argument will appear in all Toolkit APIs.

An **Efio_Fd** (i.e., **FILE ***) will be returned. If an error occurs, a NULL **Efio_Fd** will be returned and **errptr** will be set to reflect the error.

---

efio_ReadSeq()

The prototype of this API is:

```
long efio_ReadSeq(Efio_Fd fd, void *buffer, long count, Eerr_ErrorReport
**errptr)
```

efio_ReadSeq() reads **count** number of **bytes** from **fd** (i.e., file handle) into **buffer**. This is equivalent to the C **fread()** function. It is provided to guarantee portability across machines. The total number of elements successfully read is returned. If this value does not equal count, **errptr** will be set to reflect an error.

efio_Close()

The prototype of this API is:

```
long efio_Close( Efio_Fd fd, Eerr_ErrorReport **errptr)
```

efio_Close() is equivalent to the C **fclose()** function. It is provided to guarantee portability across machines.

efio_FileExists()

The prototype of this API is:

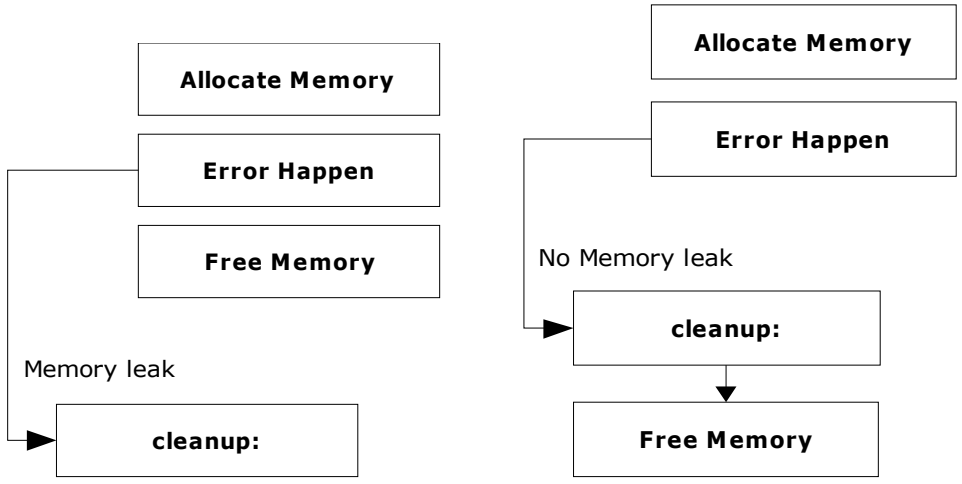
```
long efio_FileExists(Etxt_CText inpath,Eerr_ErrorReport **errptr)
```

efio_FileExists() checks to see if the indicated string inpath names an existing file. This function will return 1 if file exists. It will return 0 otherwise.

Prevent Potential Memory Leak

As the program grows in complexity we need to be aware of potential memory leaks. As we mentioned previously, when the **EERR_CHECK()** macro finds an error, it jumps directly to cleanup. If the free memory step follows directly after the **EERR_CHECK** the free memory step will be bypassed and , potential memory leaks occur (left diagram, below)

The left figure shows the memory leak problem, while the right figure shows how to prevent a memory leak:



Class Notes:

Exercise 5: Add Map & Projection Info to ConvertMDF

Exercise Objective:

In this exercise, we will improve the "**convertmdf**" program created from the previous section. We will read a Map and Projection Information from the header ***.mdh**, and then directly write Map & Projection information into "***.img**".

Packages used:

etxt
estr
eimg
exfr
eprj

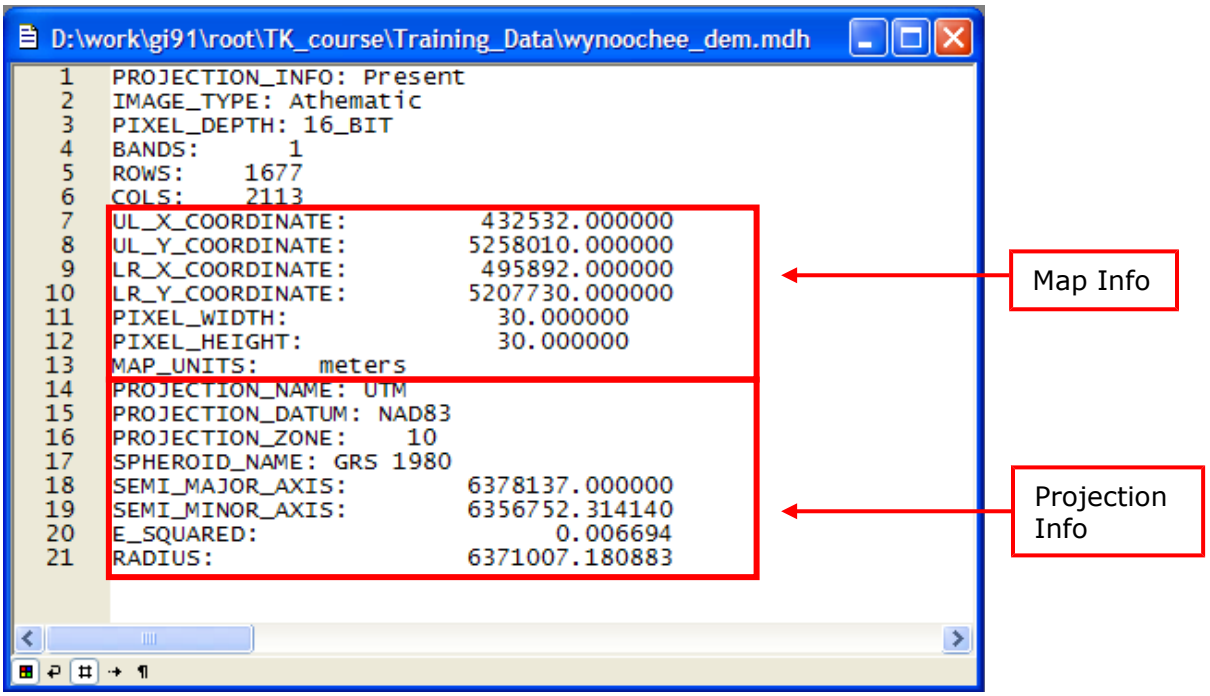
Overview

In this exercise, we will use the Map Projection Packages (i.e., **eprj**, **exfr**, **eimg**), which provide routines for storing and retrieving map information for a layer and for converting coordinates between map projections. Internally, all distance measurements (i.e., X, Y values of projection) are in meters; all angle measurements (i.e., lat, lon) are in radians.

There are two distinct entities, map information and projection information, which we want to store with our image. In this exercise, we scanned the auxiliary file to extract the necessary information, and then save them in to img file.

A Close look at MDH

The *.mdh is our header, which provides auxiliary information about map and projection. The following figure shows what the *.mdh looks like. We will not discuss the first 6 rows in the header since they were mentioned before. The content between rows 7 and 13 is the map information, and the content between row 14 and 21 is the projection information. (below)



Map Info & Projection Info

Map Information

There are two possible ways to create map information in an image:

1. **The Old way to insert Map Info**
   In the past, this was usually done by populating an **Eprj_MapInfo** structure, and then writing that structure to an image. The specific map information required was upper left X and Y map coordinates, lower right X and Y map coordinates, pixel sizes in the X and Y directions, the projection and the unit information of the image. This method of creating map information was at best, redundant; at worst, it was possible that the upper left, upper right, and pixel sizes would not correlate properly. Please refer to Challenge 1.

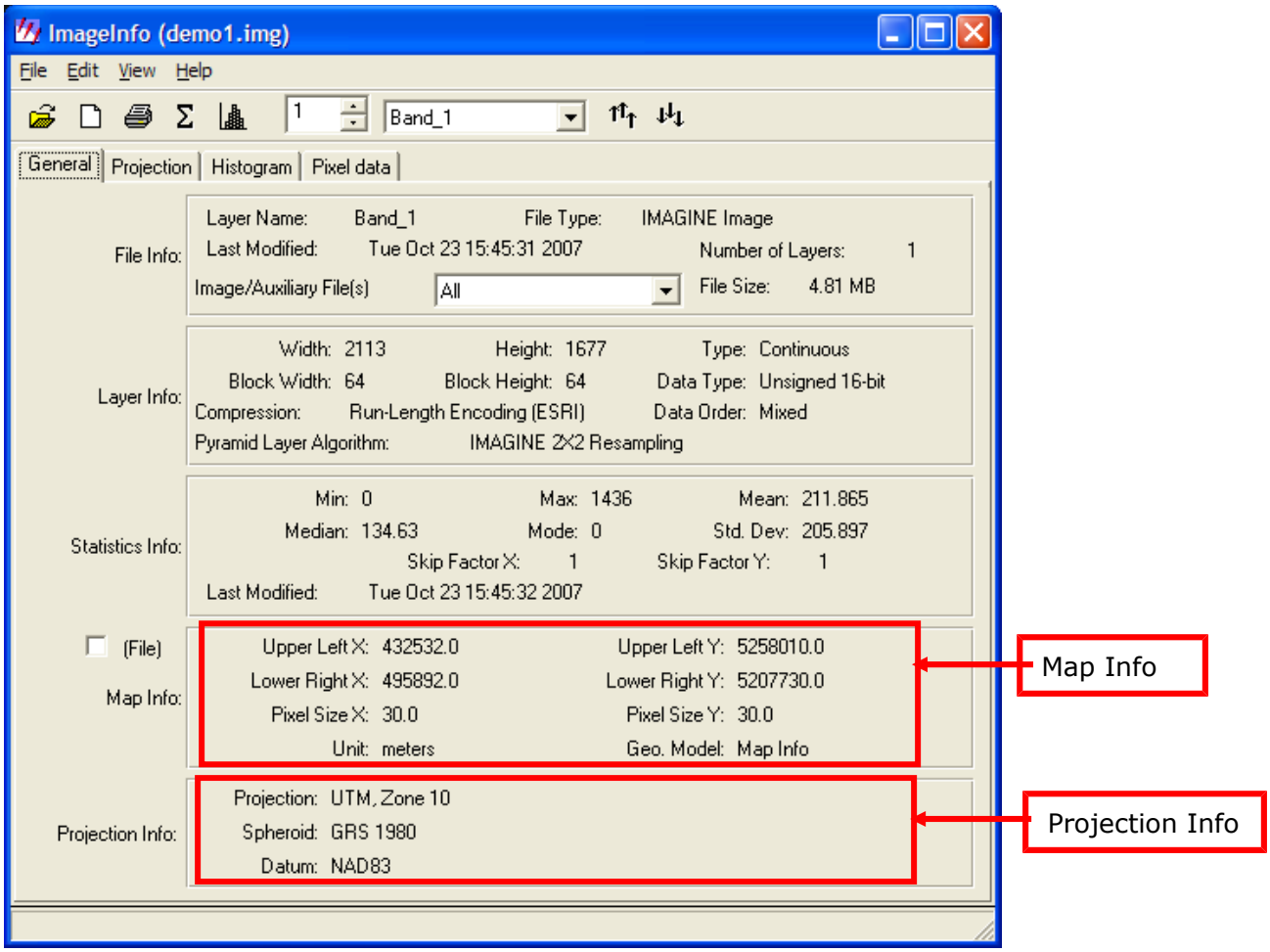
2. **The New way to insert Map Info**
   Due to advances in IMAGINE, such as reprojection and resampling on-the-fly, programmers are able to make excellent use of transformations. Therefore, students will be introduced to the transformation (**Xform**) method of creating map information. In general, this method is easier to implement than manually populating an **Eprj_MapInfo** structure, using the provided functions.

   The **Exfr** package will be used to create an Affine Transformation, based on the coefficients of only the upper left coordinates of the image, and the pixel size. Once we have the proper Xform, we will then store it with the image, along with the projection name and units, using the **eimg_LayerMapInformationWrite** function. Any IMAGINE modules which open this file should then have access to map coordinates, based on the transform that was stored with the image.

Projection Information

Due to the higher complexity of structures within structures, adding projection information is a bit more complicated than adding map information. Our first step is to create the structure to be populated. In this case, we want the **ProParameters** structure. This structure also contains spheroid and datum structures. Internally, these functions will populate the various structures based on name.

The following figure shows the output image file with the correct map and projection information. You can find them from the **Viewer->Utility->Layer Info**.



Code Snippet (Sec5_05): Read Map & Proj Info and Insert to IMG

[code part 1]

```
...

/*
** Earg DEPENDENT FUNCTION - HEADER
*/
static void set_header(int argc, char **argv)
{
      if (argc == 1) //DEFAULT IS CREATE A HEADER
        headerflag = EMSC_TRUE;
      else
      {
            if (estr_Eqic(argv[1], "0"))
                  headerflag = EMSC_FALSE;
            else if (estr_Eqic(argv[1], "1"))
                  headerflag = EMSC_TRUE;
            else
                  headerflag = EMSC_FALSE;
```

```
	}
	return;
}
...
```

[code part 2]

```
/*
** Earg DEPENDENT FUNCTION - THE CORE PROCESS ENTRY POINT.
** The heart of the processing !
*/
static void jobMain(int argc, char **argv)
{

	/*
	** CREATE IMG FILE FROM MDF
	*/
	...

	/*
	** WRITE MAP & PROJECTION INFO TO IMG
	*/
	if (headerflag)
	{
		ReadHeader(input, output, &lclerr);
	}

	/*
	** MARK SUCCESSFUL FINISH!!
	*/
	rc = 0 ;

cleanup:
	...

}
```

[code part 3]

```
/*
*****************************************************************************
**    READ MAP & PROJECTION INFO FROM USER DEFINE HEADER (*.MDH)
*****************************************************************************/
static void
ReadHeader(char *infile, char *outfile, Eerr_ErrorReport **outerr)

{
	int                         i;
	Etxt_Text                   pathpart = NULL, rootpart = NULL,
	                            headerfilename = NULL,
	                            projcomp = NULL, totalsphere = NULL,
	                            totaldatum = NULL, projectionnamep = NULL;

	Etxt_Char                   junk[50], units[10],
	                            projectionname[25], projectionname2[25] ,
	                            prodatum[25], prodatum2[25],
	                            spherename[50], spherename2[50];
```

```
double                      ulx, uly, lrx, lry,
                            spheremaj, spheremin, spheree, sphererad,
                            pixelx, pixely;
long                        nlayers, prozone, bands, rows, columns;

Efio_Fd                     headhandle       =     NULL;
Estr_StringList             *inlayernames    =     NULL;
Eimg_LayerStack             *inlayerstack    =     NULL;
Eprj_ProParameters          *paramarray      =     NULL;
Eprj_MapProjection          *projinfo        =     NULL;
Exfr_XForm                  *mapinfoXform    =     NULL;
Eimg_Layer                  *inlayer         =     NULL;


/*
** INIT LOCAL ERROR
*/
EERR_INIT("ReadHeader", outerr, lclerr);
Eint_InitToolkitData   *erdInit = eint_GetInit();


/*****************************************************************
PART I: READ HEADER
*****************************************************************/
/*
** OPEN HEADER FILE
** ASSUME THE *.MDH WILL HAVE THE SAME FILE NAME AS THE *.MDF.
*/
pathpart = efnp_FileNameGet(infile, EFNP_FNLP_ABS_FPATH, -1, &lclerr);
EERR_CHECK(lclerr, EFS0("Error efnp_FileNameGet"));

rootpart = efnp_FileNameGet(infile, EFNP_FNLP_FBASE, -1, &lclerr);
EERR_CHECK(lclerr, EFS0("Error efnp_FileNameGet"));

headerfilename = estr_Sprintf(NULL, "%s%s%s", &lclerr,
      pathpart, rootpart,".mdh");
EERR_CHECK(lclerr, EFS0("Error trying to guess header file name!"));

EERR_CHECK(!efio_FileExists(headerfilename, &lclerr),
      EFS0("Error: HEADER (.MDH) DOESN'T EXIST."));

headhandle = efio_Open(headerfilename, "r", &lclerr);
EERR_CHECK(lclerr, EFS0("Error opening .mdh file!"));


/*
** READ THE FIRST 6 LINES
**    Line 1 ~ Line 6
**    SKIP THEM BECAUSE WE ALREADY KNOW WHAT ARE THEY
*/
fscanf(headhandle, "%s%s",   &junk, &junk);
fscanf(headhandle, "%s%s",   &junk, &junk);
fscanf(headhandle, "%s%s",   &junk, &junk);
fscanf(headhandle, "%s%ld", &junk, &junk);
fscanf(headhandle, "%s%ld", &junk, &junk);
fscanf(headhandle, "%s%ld", &junk, &junk);


/*
** READ MAP INFO
```

```
**    Line 7 ~ Line 13
*/
fscanf(headhandle, "%s%lf", &junk, &ulx);            /* UPPER LEFT X   */
fscanf(headhandle, "%s%lf", &junk, &uly);            /* UPPER LEFT Y   */
fscanf(headhandle, "%s%lf", &junk, &lrx);            /* LOWER RIGHT X  */
fscanf(headhandle, "%s%lf", &junk, &lry);            /* LOWER RIGH Y   */
fscanf(headhandle, "%s%lf", &junk, &pixelx);   /* PIXEL X RESOLUTION */
fscanf(headhandle, "%s%lf", &junk, &pixely);   /* PIXEL Y RESOLUTION */
fscanf(headhandle, "%s%s",   &junk, units);          /* PIXEL UNITS    */


/*
** READ PROJECTION INFO
**    Line 14 ~ Line 21
**    NEED MORE WORK BECAUSE NAME MAY CONTAIN "white space";
**
**    FOR EXAMPLE:
**  PROJECTION NAME may be "UTM", "State Plane"..., you should
**    read the first part, check it and decide wheather or not there
**    is the second part.
**    DATUN NAME may be UTM or State Plane
**    SPHERIOD NAME may be "clark 1866", "GRS 1980", "WGS 84", ...
*/

/* READ PROJECTION NAME */
fscanf(headhandle, "%s%s", &junk, projectionname);
projectionnamep = estr_Sprintf(NULL, "%s", &lclerr, projectionname);
if (estr_Eqic(projectionnamep, "State"))
      // COMPARE STRING (CASE INSENSITIVE).
{
      fscanf(headhandle, "%s", projectionname2);
      projectionnamep = estr_Sprintf(NULL, "%s%s%s", &lclerr,
            projectionname, " ", projectionname2);
}
/* READ DATUM NAME */
fscanf(headhandle, "%s%s", &junk, prodatum);
totaldatum = estr_Sprintf(NULL, "%s", &lclerr, prodatum);
if (estr_Eqic(totaldatum, "clarke"))
{
      fscanf(headhandle, "%s", prodatum2);
      totaldatum = estr_Sprintf(NULL, "%s%s%s", &lclerr,
            prodatum, " ", prodatum2);
}
/* READ PROJECTION ZONE */
fscanf(headhandle, "%s%ld", &junk, &prozone);
/* READ SPHERIOD NAME */
fscanf(headhandle, "%s%s", &junk, &spherename);
totalsphere = estr_Sprintf(NULL, "%s", &lclerr, spherename);
if (estr_Eqic(totalsphere, "clarke") ||  estr_Eqic(totalsphere, "wgs")
      ||estr_Eqic(totalsphere, "grs"))
{
      fscanf(headhandle, "%s", spherename2);
      totalsphere = estr_Sprintf(NULL, "%s%s%s", &lclerr,
            spherename, " ", spherename2);
}
/* READ Semi major axis */
fscanf(headhandle, "%s%lf", &junk, &spheremaj);
/* READ Semi minor axis */
fscanf(headhandle, "%s%lf", &junk, &spheremin);
/* READ ESquared */
fscanf(headhandle, "%s%lf", &junk, &spheree);
```

```
/* READ Radius */
fscanf(headhandle, "%s%lf", &junk, &sphererad);


/*
** CLOSE HEADER FILE, WE DON'T NEED IT ANYMORE
*/
efio_Close(headhandle, &lclerr);
EERR_CHECK(lclerr, EFS0("Error efio_Close"));
headhandle = NULL;


/*****************************************************************
PART II: WRITE TO IMAGINE FILE
*****************************************************************/
/*
** PREPARE MAP INFO
**    simply create the transform matrix for file->map, and then
**    create the invert transform for map->file
*/
mapinfoXform = exfr_XFormCreateUsingCoeffs( pixelx, 0.0, ulx,
      0.0, -pixely, uly, &lclerr );
EERR_CHECK(lclerr, EFS0("Error setting mapinformation XForm!"));

exfr_XFormInvert ( mapinfoXform, mapinfoXform, &lclerr );
EERR_CHECK(lclerr, EFS0("Error setting mapinformation XForm!"));


/*
** PREPARE PROJECTION INFO
**    First create a Eprj_ProParameters structure, fill in the
**    structure with Spheroid name, Datun name, zone name (zone number
**    is for UTM or state plane); and then transfer it to
**    Eprj_MapProjection structure.
*/
paramarray = eprj_ProParametersCreateByName(projectionname, &lclerr);
EERR_CHECK(lclerr, EFS0("Error creating projection info!"));

eprj_SpheroidByName (erdInit, totalsphere, paramarray->proSpheroid,
      &lclerr);
EERR_CHECK(lclerr, EFS0("Error setting spheroid!"));

eprj_DatumByName(erdInit, totalsphere, totaldatum,
      paramarray->proSpheroid->datum, &lclerr);
EERR_CHECK(lclerr, EFS0("Error setting datum!"));

paramarray->proZone = prozone;

projinfo = eprj_ProjectionInit (erdInit, paramarray, &lclerr);
EERR_CHECK(lclerr, EFS0("Error initializing map projection structure!"));


/*
** INSERT MAP INFO & PROJECTION INFO BY LOOP
*/
inlayernames = eimg_LayerGetNames(outfile, erdInit, &lclerr);
EERR_CHECK(lclerr, EFS0("Error getting layer names of input file!"));

nlayers = inlayernames->count;
EERR_CHECK(nlayers < 1, EFS0("You didn't specify a valid input file!"));
```

```
    for (i=0; i <nlayers; i++)
    {
        inlayer = eimg_LayerOpen(inlayernames->strings[i], erdInit, &lclerr,
            EIMG_LAYER_OPTION_END);
        EERR_CHECK(lclerr, EFS1("Error opening layer #", i));

        /* INSERT MAP INFO */
        eimg_LayerMapInformationWrite( inlayer, projectionnamep, units,
            mapinfoXform, &lclerr );
        EERR_CHECK(lclerr, EFS1("Error writing map info structure to layer #", i));

        /* INSERT PROJECTION INFO */
        eimg_LayerMapProjectionWrite( inlayer, projinfo, &lclerr );
        EERR_CHECK(lclerr, EFS1("Error writing projection info structure \
                                        to layer #", i));

        eimg_LayerClose(inlayer, &lclerr);
        EERR_CHECK(lclerr, EFS1("Error closing layer #", i));
        inlayer = NULL;
    }


cleanup:

    /*
    ** FREE EVERYTHING, NO MEMORY LEAK
    */
    if ( mapinfoXform )
    {
        exfr_XFormFree( &mapinfoXform, &lclerr );
        EERR_DELETE( lclerr );
        mapinfoXform=NULL;
    }
    if ( paramarray )
    {
        eprj_ProParametersFree(& paramarray);
        paramarray = NULL;
    }
    if ( projinfo )
    {
        eprj_ProjectionFree( &projinfo);
        projinfo = NULL;
    }
    if ( inlayernames )
    {
        estr_StringListDelete( inlayernames, &lclerr);
        EERR_DELETE( lclerr );
        inlayernames = NULL;
    }
    if ( inlayer )
    {
        eimg_LayerClose(inlayer , &lclerr);
        EERR_DELETE( lclerr );
        inlayer = NULL;
    }
    if ( headhandle )
    {
        efio_Close(headhandle, &lclerr);
        EERR_DELETE( lclerr );
        headhandle = NULL;
```

```
        }
        return;
}
```

Code Explanation:

Write Map Info and Projection Info

We use **eimg_LayerMapInformationWrite** function to write map information to the layer, and the **eim_LayerMapProjectionWrite** function to write map projection information to the layer. The following is a detailed description:

---

eimg_LayerMapInformationWrite()

The prototype of this API is:

```
void eimg_LayerMapInformationWrite(Eimg_Layer *layer,
                        Etxt_Text proName,
                        Etxt_Text units,
                        Exfr_XForm *xForm,
                        Eerr_ErrorReport errptr)
```

This function writes map information to be associated with the specified **Eimg_Layer**, **layer**, Any previously existing map information will be overwritten. This function will not remove any existing projection information. It is the caller's responsibility to ensure that the projection information associated with the layer is consistent with the Map information associated with the layer.

proName, **units**, **xForm** must be either all NULL or all non-NULL. If they are all non-NULL, the map information contained in the parameters will be written the layer. If they are all NULL, any map information associated with the layer will be deleted.

proName contains a projection name which identifies the map system of the layer. This may be the **eprj_ProjectionNameUnknown**.

units contains the map units upon which **xForm** is based.

xForm contains the map to layer pixel transformation for the layer.

---

eimg_LayerMapProjectionWrite()

The prototype of this API is:

```
void eimg_LayerMapProjectionWrite(Eimg_Layer *layer,
                        Eprj_MapProjection *projection,
                        Eerr_ErrorReport  errptr)
```

This function associates a map projection, **projection**, with an Eimg_Layer, **layer**. This map projection describes the earth to map system transformation for the map system associated with the layer. If function will disassociated any previously written map projection from the layer so if the projection is NULL, any map projection associated with the layer will be deleted.

The exfr package

The **Exfr** package will be used to create an Affine Transformation, based on the coefficients of only the upper left coordinates of the image, and the pixel size. In general, an affine transform is composed of one or several linear transformations (rotation, scaling or shear) and translation (shift). In order to transform from file to map, and map to file, we need the following APIs.

The transform created by **exfr_XFormCreateUsingCoeffs()** will be used in calculating the map coordinate from file coordinate, while the inverted transform created by **exfr_XFormInvert()** will get the file coordinate back from the map coordinate.

---

exfr_XFormCreateUsingCoeffs ()

The prototype of this API is:

```
Exfr_XForm * exfr_XFormCreateUsingCoeffs(double a, double b, double c,
         double d, double e,double f, Eerr_ErrorReport  inerr)
```

This function creates an arbitrary affine transform using the given coefficients. The result is of the form:
a = pixel size in the X direction.
b = 0.0 (file ULY).
c = upper left X Coordinate.
d = 0.0 (file ULX).
e = pixel size in the Y direction.
f = upper left Y Coordinate.

$$\text{Transform matrix } T = \begin{bmatrix} a & b & c \\ d & e & f \\ 0 & 0 & 1 \end{bmatrix}$$

Map = T * file
The created transform will be returned.

---

exfr_XFormInvert()

The prototype of this API is:

```
Exfr_XForm * exfr_XFormInvert ( Exfr_XForm *inXForm, Exfr_XForm *outXForm,
                  Eerr_ErrorReport  err )
```

This function will invert an Exfr_XForm linked-list into new Exfr_XForm. The address of the ouput Exfr_XForm structure is returned.

File = T^{-1} * Map

The eprj package

The Map Projection (**eprj**) package provides tools for storing and retrieving map projection information for a layer and for converting coordinates between map projections. It also contains functions necessary for developing projections that are external to the ERDAS IMAGINE package.

Eprj_ProParameters

The prototype of this struct is:

```
typedef struct {
    Eprj_ProType proType; /* projection type */
    long proNumber; /* projection number for internal projections */
    Eprj_CharStrPtr proExeName; /* projection executable name for
                        external projections */
    Eprj_CharStrPtr proName; /* projection name */
    long proZone; /* projection zone (UTM, SP only) */
    Eprj_DblArrayPtr proParams; /* projection parameters array in
                        the GCTP form */
    Eprj_Spheroid *proSpheroid; /* projection spheroid */
} Eprj_ProParameters;
```

This struct is used to define the map projection for a layer.
proType defines whether the projection is internal or external.
0 = “EPRJ_INTERNAL”; 1=”EPRJ_EXTERNAL”
proNumber is the projection number for internal projections. The current internal projections are:

0="Geographic(Latitude/Longitude)"
1="UTM"
2="State Plane"
3="Albers Conical Equal Area"
4="Lambert Conformal Conic"
5="Mercator"
6="Polar Stereographic"
7="Polyconic"
8="Equidistant Conic"
9="Transverse Mercator"
10="Stereographic"
11="Lambert Azimuthal Equal-area"
12="Azimuthal Equidistant"
13="Gnomonic"
14="Orthographic"
15="General Vertical Near-Side Perspective"
16="Sinusoidal"
17="Equirectangular"
18="Miller Cylindrical"
19="Van der Grinten I"
20="Oblique Mercator (Hotine)"
21="Space Oblique Mercator"
22="Modified Transverse Mercator"

proExeName is the name of executable to run for an external projection.

proName is the name of the projection. This will be one of the names given above in the description of proNumber.

proZone is the zone number for internal State plane or UTM projections.

proParams is the array of parameters for the projection.

The following table defines the contents of the proParams array which is defined above. The Parameters column defines the meaning of the various elements of the proParams array for the different projections. Each one is described by one or more statements of the form n: Description. n is the index into the array.

	Name	**Parameters**
0	"Geographic(Latitude/Longitude)"	None Used
1	"UTM"	**3**: 1=North, -1=South for example, 3 mean proParams.data**[3]** = 1/-1
2	"State Plane"	**0**: 0=NAD27, 1=NAD83 for example, 3 mean proParams.data**[0]** = 0/1
3	"Albers Conical Equal Area"	2: Latitude of 1st standard parallel 3: Latitude of 2nd standard parallel 4: Longitude of central meridian 5: Latitude of origin of projection 6: False Easting 7: False Northing
4	"Lambert Conformal Conic"	2: Latitude of 1st standard parallel 3: Latitude of 2nd standard parallel 4: Longitude of central meridian 5: Latitude of origin of projection 6: False Easting 7: False Northing
5	"Mercator"	4: Longitude of central meridian 5: Latitude of origin of projection 6: False Easting 7: False Northing
6	"Polar Stereographic"	4: Longitude directed straight down below pole of map. 5: Latitude of true scale. 6: False Easting 7: False Northing.
7	"Polyconic"	4: Longitude of central meridian 5: Latitude of origin of projection 6: False Easting 7: False Northing
8	"Equidistant Conic"	2: Latitude of standard parallel (Case 0) 2: Latitude of 1st Standard Parallel (Case 1) 3: Latitude of 2nd standard Parallel (Case 1) 4: Longitude of central meridian 5: Latitude of origin of projection 6: False Easting 7: False Northing 8: 0=Case 0, 1=Case 1.
9	"Transverse Mercator"	2: Scale Factor at Central Meridian 4: Longitude of center of projection 5: Latitude of center of projection 6: False Easting 7: False Northing
10	"Stereographic"	4: Longitude of center of projection 5: Latitude of center of projection 6: False Easting 7: False Northing
11	"Lambert Azimuthal Equal-area"	4: Longitude of center of projection

		5: Latitude of center of projection 6: False Easting 7: False Northing
12	"Azimuthal Equidistant"	4: Longitude of center of projection 5: Latitude of center of projection 6: False Easting 7: False Northing
13	"Gnomonic"	4: Longitude of center of projection 5: Latitude of center of projection 6: False Easting 7: False Northing
14	"Orthographic"	4: Longitude of center of projection 5: Latitude of center of projection 6: False Easting 7: False Northing
15	"General Vertical Near-Side Perspective	2: Height of perspective point above sphere. 4: Longitude of center of projection 5: Latitude of center of projection 6: False Easting 7: False Northing
16	"Sinusoidal"	4: Longitude of central meridian 6: False Easting 7: False Northing
17	"Equirectangular"	4: Longitude of central meridian 5: Latitude of True Scale. 6: False Easting 7: False Northing
18	"Miller Cylindrical"	4: Longitude of central meridian 6: False Easting 7: False Northing
19	"Van der Grinten I"	4: Longitude of central meridian 6: False Easting 7: False Northing
20	"Oblique Mercator (Hotine)"	2: Scale Factor at center of projection 3: Azimuth east of north for central line. (Case 1) 4: Longitude of point of origin (Case 1) 5: Latitude of point of origin. 6: False Easting 7: False Northing. 8: Longitude of 1st Point defining central line (Case 0) 9: Latitude of 1st Point defining central line (Case 0) 10: Longitude of 2nd Point defining central line. (Case 0) 11: Latitude of 2nd Point defining central line (Case 0). 12: 0=Case 0, 1=Case 1
21	"Space Oblique Mercator"	4: Landsat Vehicle ID (1-5) 5: Orbital Path Number (1-251 or 1-233) 6: False Easting 7: False Northing
22	"Modified Transverse Mercator"	6: False Easting 7: False Northing

proSpheroid is the parameters of the spheroid used to approximate the earth. See the description for the Eprj_Spheroid object.

Eprj_MapProjection

The prototype of this struct is:

```
typedef struct {

Eprj_ProParameters *parmArray; /*pointer to the projection parameters array */
EPRJ_PARAMETERS_PTR parameters; /*pointer to parameters structure */
void (*toLL) __(( Eprj_ProjPoint *,
EPRJ_PARAMETERS_PTR,
Eprj_GeoPoint *, long,
Eerr_ErrorReport   )); /* pointer to function for inverse transformation */

void (*fromLL) __(( Eprj_GeoPoint *,
EPRJ_PARAMETERS_PTR,
Eprj_ProjPoint *, long,
Eerr_ErrorReport   )); /* pointer to function for forward transformation */

EPRJ_PARAMETERS_PTR (*copyParameters) __((
EPRJ_PARAMETERS_PTR,
EPRJ_PARAMETERS_PTR,
Eerr_ErrorReport   )); /* pointer to function to copy the local parameters
structure */

Emsc_Boolean (*proParametersEqual) __((
Eprj_ProParameters *,
Eprj_ProParameters *,
Eerr_ErrorReport   )); /* pointer to the routine for checking that the 2 input
parmArray's are equivalent */

void (*quit) __(( EPRJ_PARAMETERS_PTR,
Eerr_ErrorReport   )); /* pointer to the quit routine for the projection */
} Eprj_MapProjection;
```

eprj_ProParametersCreateByName ()

The prototype of this API is:

```
Eprj_ProParameters * eprj_ProParametersCreateByName( Etxt_Text name,
                            Eerr_ErrorReport  err)
```

This function creates an empty projection of type implied by the ***name***.

Eprj_Shperoid

The prototype of this struct is:

```
typedef struct {
         Eprj_CharStrPtr sphereName; /* name of the ellipsoid */
         double a; /* semi-major axis of ellipsoid */
         double b; /* semi-minor axis of ellipsoid */
         double eSquared; /* eccentricity-squared */
         double radius; /* radius of the sphere */
         Eprj_Datum *datum; /* The datum structure*/
```

```
} Eprj_Spheroid;
```

This struct is used to describe spheroid parameters used to describe the shape of the earth.
shperiodName is the name of the spheroid/ellipsoid. This name can be found in **<IMAGINE_HOME>\etc\spheroid.tab**
a is the semi-major axis of the ellipsoid in meters.

b is the semi-minor axis of the ellipsoid in meters.

eSquared is the eccentricity of the ellipsoid.

radius is the radius of the spheroid in meters.

---

eprj_SpheroidByName()

The prototype of this API is:

```
void eprj_SpheroidByName (
         Eint_InitToolkitData *erdinit,/* toolkit initialization data . */
         Etxt_Text  spheroidName,  /* the spheroid name. */
         Eprj_Spheroid *spheroid,  /* the output spheroid parameters. */
         Eerr_ErrorReport  err     /* error handling structure pointer. */
)
```

This function will fill in the spheroid parameter ***spheroid***, given the ***spheroidName***.

Eprj_Datum

The prototype of this struct is:

```
typedef struct {
         Eprj_CharStrPtr datumname; /* name of the datum */
         Eprj_DatumType type; /* The datum type */
         Eprj_DblArrayPtr params; /* The parameters for type
                                        EPRJ_DATUM_PARAMETRIC */
         Eprj_CharStrPtr gridname; /* name of the grid file */
         FILE *file; /* the grid file */
} Eprj_Datum;
```

This struct is used to record the datum information which is part of the projection information for a *.img file.
datumname is the name of the datum, like "**NAD83**", or "**NAD27**"...
type is the datum type which could be one of three different types: parametric type, grid type, and regression type.
params are the seven parameters of a parametric datum which describe the translations, rotations, and scale change between the current datum and the reference datum **WGS84**.
gridname is the name of grid datum file which stores the coordinate shifts among North America Datums **NAD27**, **NAD83** and **HARN**.

eprj_DatumByName()

The prototype of this API is:

```
void eprj_DatumByName (
    Eint_InitToolkitData *erdinit,  /* toolkit initialization data . */
    Etxt_Text  spheroidName,        /* the spheroid name. */
    Etxt_Text  datumName,           /* the datum name. */
    Eprj_Datum *datum,              /* the output datum parameters. */
    Eerr_ErrorReport  err           /* error handling structure pointer. */
)
```

This function will fill in the datum parameter ***datum***, given the ***datunName***.

The estr package

The String Manipulation (**estr**) package currently provides a variety of routines for character string manipulation. They are categorized into the following six major groups:

	Purpose	Functions (APIs)
1	General string manipulation	These functions can be used for variety of string manipulation operations such as compare, change, duplicate, and analyze. **Compare:** **estr_WildCompare** **estr_Eqic, estr_Eqnic, estr_Eq, estr_Eqn** **estr_Ne, estr_Gt, estr_Ge, estr_Lt, estr_Le** **estr_CompareString,** **estr_SubString,** **estr_LooseMatch** **estr_IsCharPresent** **estr_IsWild** **estr_MatchSequence** **Change:** **estr_LowerCase, estr_UpperCase,** **estr_StringCat,** **estr_Sprintf** **estr_MetaStringToString** **Duplicate:** **estr_Duplicate,** **estr_StringCopy** **estr_QuotedDuplicate** **Analyze** **estr_CharCount**
2	Filename string parsing	These functions can be used to parse/manipulate the filename strings. You can do operations such as get filename, extension, path name etc. **estr_GetPathPart** **estr_GetRootPart** **estr_GetNamePart** **estr_GetLayerPart** **estr_GetNonNodePart** **estr_GetExtPart**

		estr_GetBestFitParts **estr_GetPathList** **estr_FreePathList** **estr_AddSubPath** **estr_PathExpand** **estr_GetServerPart** **estr_GetProtocolPart** **estr_GetLocalFilename**
3	String List functions	These functions can be used to manipulate the datatype Estr_StringList **estr_StringListCreate** **estr_StringListCopy** **estr_StringListDelete** **estr_StringListAppend** **estr_StringListAppendUniq** **estr_StringListCount** **estr_StringToBoolean** **estr_StringToStringList** **estr_DoubleToStringList** **estr_LongToStringList** **estr_StringListQuotedCopy**
4	String expression evaluation	**estr_EvaluateString** **estr_StringToBoolean** **estr_StringToChar** **estr_StringToIntList**
5	Manipulate strings used for numeric formatting	**estr_XLFormatCreate** **estr_XLFormateFree** **estr_XLFormatPrintNumber**
6	Miscellaneous functions	**estr_ErrnoString** **estr_IsDir** **estr_GetCwd** **estr_IsFile** **estr_GetEnv** **estr_PutEnv** **estr_CheckEnv**

---

estr_Eqic()

The prototype of this API is:

```
int estr_Eqic(Etxt_CText string1, Etxt_CText string2)
```

This function compares the string passed in **string1** to the string **string2**. This is similar **estr_Eq()** except that this function is case **insensitive**.

Returns 1 if the strings are equal, 0 otherwise.

---

estr_Sprintf()

The prototype of this API is:

```
Etxt_Text estr_Sprintf (Etxt_Text outString, Etxt_CText format,
                        Eerr_ErrorReport  inerrorreport,...)
```

This function performs formatted output to the indicated character string. The function is essentially the same as **sprintf()**, except that it will create adequate storage for the output string if outString is NULL.

This function returns a pointer to the destination character string.

The etxt package

(**char***): The char type is used to store the integer value of a member of the representable character set. That integer value is the ASCII code corresponding to the specified character.

Etxt_Text: **Etxt_Text** should be used instead of C's standard "**char ***" data type, whenever "**char ***" is used to present a text string that can be seen by a user. Also the **Etxt_Char** should be used instead of C's standard "**char**". The benefit of doing this is making your program compatible with UNICODE or non-UNICODE character set by specifying the preprocessor definition "UNICODE".

The **etxt** Package is a means to develop an application that can be built using an alternate type of character set, just as Windows NT applications can be built and run in UNICODE mode. etxt is not a means to convert between one type of string to another. Applications that wish to work with more than one type of string should use facilities supplied by the Operating System to convert between them.

The IMAGINE Developer's Toolkit will only be available compiled with 8-bit character strings. By migrating from "**char ***" to **Etxt_Text**, when it is appropriate to do so, it may be possible in the future to build a version of IMAGINE and its toolkit based upon UNICODE strings, or perhaps another form of wide-character strings.

Class Notes:

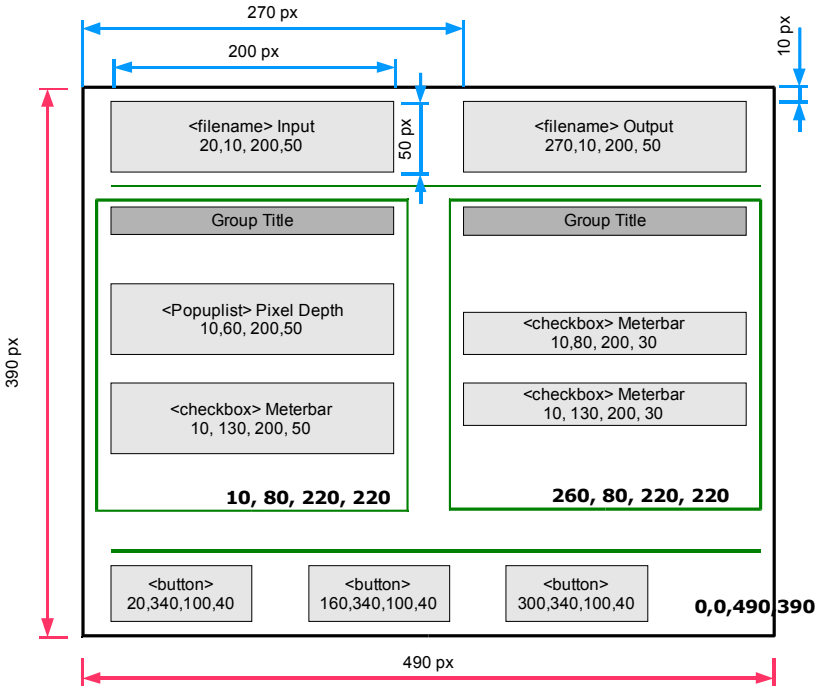
Exercise 6: Add GUI to ConvertMDF

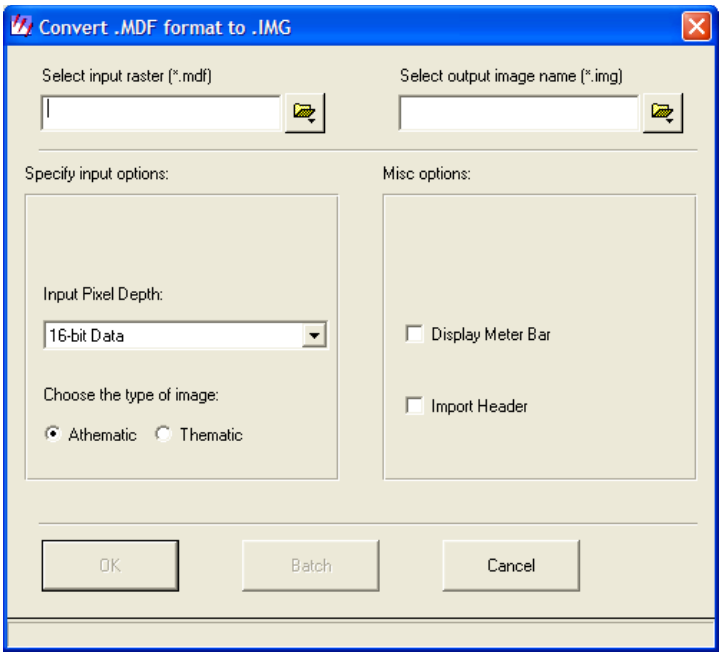
Exercise Objective:

In this exercise, we will add an EML GUI to the command line. This is nothing new, you can make a nice GUI by using the knowledge learned in previous Sections.

Design the GUI

We can re-use the EML code we developed in previous sections without making many change. You will find this layout is handy for most JOB applications because it covers most GUI components frequently used, and has enough space for future use and extend.



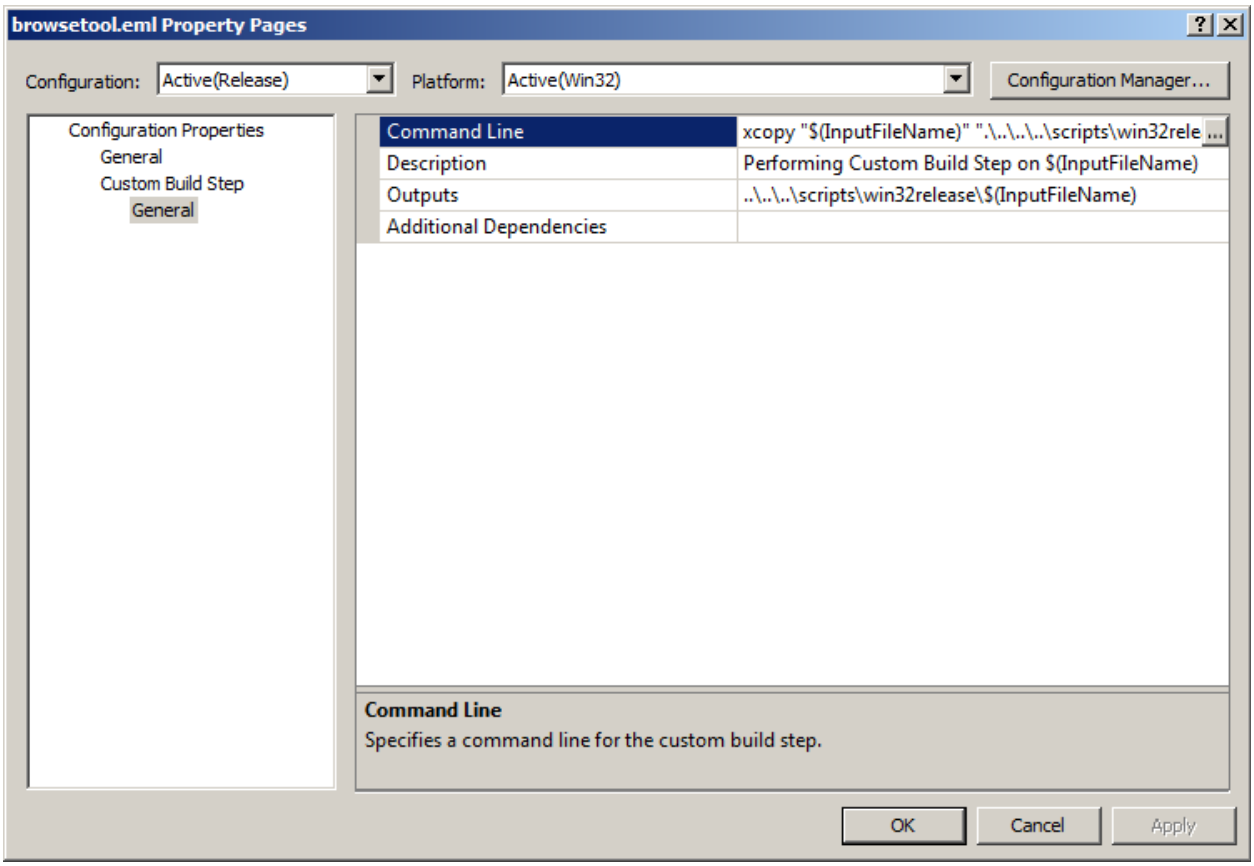


Compile EML Script in Microsoft Visual Studio 2008

In order to let IMAGINE find your EML script, you have to copy it to the **<IMAGINE_HOME>\scripts\Win32Release** folder. We will now learn how to integrate this step into Microsoft Visual Studio 2008.

You can create the custom build configuration for EML in Visual Studio. **RMB** your eml, and select "**Propertiy**", then add the following settings.

This will copy the eml from your working directory to **<IMAGINE_HOME>\scripts\Win32Release** folder, so IMAGINE can find your EML scripts.



Command Line	**xcopy "$(InputFileName)" ".\..\..\..\scripts\Win32Release" /y /r /d /f**
Description	**Performing Custom Build Step on $(InputFileName)**
Outputs	**..\..\..\scripts\Win32Release\$(InputFileName)**

Code Snippet (Sec5_06): ConvertMDF.eml

```
/*
******************************************************************************
**
**    ConvertMDF.eml
**    Let you input the following argument through GUI:
**          1. Pixel Depth
**          2. Image Type
**          3. chk_header
**          4. chk_meter Bar Display
**          5. Input filename / output filename
**
******************************************************************************
*/

component Convertmdf
{
      frame frm_Convertmdf;
      frame frm_Convertmdf
      {
            title "Convert .MDF format to .IMG";
            geometry 50, 50,490,390;           # GEOMETRY BASED ON SCREEN COORDINATE
            statusbar;                         # GEOMETRY DOES NOT INCLUDE STATUSBAR

/*
******************************************************************************
**
**    DECLARATION
**
******************************************************************************
*/
            /*
            ** FRAMEPART FORWARD DECLARATION
            */

            filename fln_Input;                /*INPUT FILES*/
            filename fln_Output;
            group grp_InputOptions;            /*INPUT OPTIONS*/
                  popuplist pop_PixelType;
                  radiobutton rad_ImageType;
            group grp_MiscOptions;             /*MISC OPTIONS*/
                  checkbox chk_meter;
                  checkbox chk_header;
            button btn_OK;                     /*BUTTONS*/
            button btn_Batch;
            button btn_Cancel;

/*
******************************************************************************
**
**    INPUT / OUTPUT FILES
**
******************************************************************************
*/
            filename fln_Input {
            title above left "Select input raster";
                  info "Choose the MDF file you want to convert.";
```

```
            geometry 20,10, 200, 50;
            shortform;
            select getpref("eml" "default_data_path") + "/*.mdf";
            on filenamechoosen
            {
                  set fln_Output = getpref("eml" "default_output_path") + "/" +
                  froot($fln_Input) + ".img";
                  testuserinput();
            }
      }

      filename fln_Output {
            title above left "Select output image name";
            info "Choose the IMG file you wish to create.";
            geometry 270, 10, 200, 50;
            newfile;
            shortform;
            filetypedef "raster (*.img)";
            select getpref("eml" "default_data_path") + "/*.img";
            on filenamechoosen
            {
                  testuserinput();
            }
      }
      line lin_1
      { geometry 20,70,460,1; layout horizontal;}

/*
*****************************************************************************
**
**    INPUT OPTIONS
**
*****************************************************************************
*/
      group grp_InputOptions
      {
            geometry 10, 80, 220,220;
            title above left "Specify input options:";

            popuplist pop_PixelType
            {
                  title above left "Input Pixel Depth:";
                  info "Select input pixel type! (8-bit or 16-bit)";
                  geometry 10, 60, 200, 50;
                  titlelist { "8-bit Data", "16-bit Data"};
                  names {"u8", "u16"};         # VALUE OF THE POPUPLIST
                  value "u8";            # SETUP DEFAULT CHOICE
                  on valuechanged { echo $pop_PixelType; }
            }

            radiobutton rad_ImageType
            {
                  title above left "Choose the type of image:";
                  info "Select the image type! (thematic or athematic)";
                  geometry 10, 130, 200, 50;
                  layout horizontal;
                  options {"athematic", "thematic"};       # VALUE OF THE RADIOBUTTON
                  value "athematic";                       # SETUP DEFAULT CHOICE
                  titlelist { "Athematic", "Thematic"};
                  on valuechanged {echo $rad_ImageType;}
            }
```

```
            } /* end group grp_Inputoptions */

/*
*****************************************************************************
**
**    MISC OPTIONS
**
*****************************************************************************
*/
            group grp_MiscOptions {
                  title above left "Misc options:";
                  geometry 260, 80, 220, 220;

                  checkbox chk_meter{
                        title "Display Meter Bar";
                        info "Display Meter Bar?";
                        geometry 10,80,200,30;
                        value 1;    # SETUP DEFAULT CHOICE
                  }

                  checkbox chk_header {
                        title "Import Header";
                        info "Import Header Information?";
                        geometry 10,130,200,30;
                        value 1;    # SETUP DEFAULT CHOICE
                  }
            } /* end group grp_MiscOptions*/
            line lin_2
            { geometry 20,330,460,1; layout horizontal;}

/*
*****************************************************************************
**
**    BUTTONS
**
*****************************************************************************
*/
            button btn_OK {
                  title "OK";
                  info "Run process on specified files now";
                  geometry 20,340,100,40;
                  on mousedown {
                        pro_convertmdf();
                  }
            }

            button btn_Batch {
                  title "Batch";
                  info "Set this job to process at a future time.";
                  geometry 160, 340, 100, 40;
                  on mousedown {
                        startbatchsingle;
                        batchjobname froot($fln_Output);
                        pro_convertmdf();
                  }
            }

            button btn_Cancel {
                  title "Cancel";
                  info "Close do not run process";
```

```
                geometry 300, 340, 100, 40;
                on mousedown {
                      unload;
                }
          }

/*
*****************************************************************************
**
**    FRAME PROCEDURES
**
*****************************************************************************
*/
          on pro_convertmdf
          {
                job convertmdf
                      -in $fln_Input
                      -out $fln_Output
                      -p $pop_PixelType
                      -t $rad_ImageType
                      -m $chk_meter
                      -h $chk_header;
          }

          on framedisplay
          {
                testuserinput();
          }

          on testuserinput
          {
                #Check File name
                if ($fln_Input!="" && fln_Output!="")
                {
                      enable btn_OK;
                      enable btn_Batch;
                }
                else
                {
                      disable btn_OK;
                      disable btn_Batch;
                }
          }
    }  # CLOSE OF FRAME

/*
*****************************************************************************
**
**    COMPONENT PROCEDURES
**
*****************************************************************************
*/
    on startup {
          display frm_Convertmdf;
    }


} # CLOSE OF COMPONENT
```

Class Notes:

Exercise 7: Add Metering Bar to ConvertMDF

Exercise Objective:

In this exercise we will add metering support to **convertmdf** program. We will use the metering package to keep the user informed as to what a JOB is doing and how much of it has been compeleted.

Packages used:

emet

How metering works in IMAGINE

The Metering bar is a feature of an IMAGINE JOB. You will find the “job” keyword in your EML code.

```
on ok_batch
{
     job convertmdf
      -in $fln_Input
      -out $fln_Output
      -p $pop_PixelType
      -t $rad_ImageType
      -m $chk_meter
      -h $chk_header;
}
```

Every IMAGINE job will have a default metering bar. In this case, whether or not you enable or disable the metering bar; you will always see the metering bar.

1. If you enable the meter option, you will see the title of your program and the actual ‘percent done’. .
2. If you disable the meter option, you will see the title string will be blank , and the percent done will display 0 until the program finishes. When the program completes the percent done suddenly turns to 100. The reason is because the meter information structure is not created, so IMAGINE does not know which meter bar needs to be updated.

If you remove the “**job**” keyword from your EML code, your metering bar will go away even if you enable the meter option from your EML GUI.

As a summary, with the “**job**” keyword on, you can not really disable the meter bar. We should always use the “**job**” keyword for an IMAGINE job. The meter bar is extremely helpful for updating the current job status and percent done.

The Process Logic

In this exercise we will use the metering package to keep the user informed as to what the JOB is doing and how much of it has been compeleted.

We should follow the metering procedures:

1. Create a meter.
2. Print initial 0 to meter.
3. Set the meter information.
4. Set the current task name to reflect what is happening.
5. Do something.
6. Print current progress to meter.
7. If the task has changed then set the task name to reflect what is happening.
8. Repeat steps 5 thru 7 until finished.
9. Print 100 to meter (just in case your calculation is under).
10. Delete meter.

Note: The boxes shown in the code below outlines the code you will be adding during this exercise.

Code Snippet (Sec5_07): Add Metering Support

```
/*
**  Earg DEPENDENT FUNCTION - METER
*/
static void set_meter(int argc, char ** argv)
{
    EERR_INIT("set meter", &lclerr, lclerr);

    if (argc == 1) //Default with Meter display
    {
        meter = emet_MeterInfoCreate("Starting process", //Task Name in the Session Manager.
                                     "Convert MDF",   //Meter display name
                                     stdout, &lclerr);
        EERR_CHECK(lclerr, EFS0("Error creating MeterInfo!"));
    }
    else
    {
        if (estr_Eqic(argv[1], "0")) //No Meter display
        {
            meter = NULL;
        }
        else if (estr_Eqic(argv[1], "1"))
        {
            meter = emet_MeterInfoCreate("Starting process",
                                                "Convert MDF", stdout, &lclerr);
            EERR_CHECK(lclerr, EFS0("Error creating MeterInfo!"));
        }
        else
        {
            meter = NULL;
        }
    }

cleanup:
    EERR_SHOW(lclerr, EERR_DEBUG);

    return;
}

/*
**  Earg DEPENDENT FUNCTION - THE CORE PROCESS ENTRY POINT.
**  The heart of the processing !
*/
static void jobMain(int argc, char ** argv)
{
      Efio_Fd                       handle      = NULL;   //INIT FILE DESCRIPTOR
      long                          numbands, numrows, numcols;
      long                          bytesperpixel, i, j;
      Eimg_PixelRect                *pixelRect = NULL; //A buffer structure
      Eimg_Layer                    *layer      = NULL;
```

```
char                          *layername  = NULL;

EERR_INIT("jobMain", &lclerr, lclerr);

/*
**  CHECK INPUT, OUTPUT (REQUIRED)
*/
EERR_CHECK(!input, EFS0("Error: INPUT FILENAME DOESN'T EXIST."));
EERR_CHECK(!output, EFS0("Error: OUTPUT FILENAME DOESN'T EXIST."));

/**** % METER % *****
** INIT METER INFO
*******************/
emet_MeterInfoSet(meter, 0.0, 100.0, &lclerr);
EERR_CHECK(lclerr, EFS0("Error setting the meter info!"));

emet_MeterInfoChangeTaskName (meter, "Convert MDF to IMG...", &lclerr);
EERR_CHECK(lclerr, EFS0("Error changing name of meter info!"));

/*
**  READ FIRST 12 BYPEs
*/
handle = efio_Open(input, "rb", &lclerr, NULL);
EERR_CHECK(lclerr, EFS0("Error opening generic file!"));

efio_ReadSeq (handle, (void*) &numbands, sizeof(long), &lclerr);
      // LONG = 32 BITs = 4 BYTEs
EERR_CHECK(lclerr, EFS0("Error getting # of bands from file!"));
      // READ BINARY DATA BIT BY BIT

efio_ReadSeq (handle, (void*) &numrows, sizeof(long), &lclerr);
EERR_CHECK(lclerr, EFS0("Error getting # of rows from file!"));

efio_ReadSeq (handle, (void*) &numcols, sizeof(long), &lclerr);
EERR_CHECK(lclerr, EFS0("Error getting # of columns from file!"));

/*
**  CREATE IMG FILE FROM MDF
*/
pixelRect = eimg_PixelRectCreate (numcols, 1, pixeltype, &lclerr);
EERR_CHECK(lclerr, EFS0("Error eimg_PixelRectCreate"));

if (pixeltype == EGDA_TYPE_U16) bytesperpixel = 2;
else bytesperpixel = 1;

if ( efio_FileExists(output, &lclerr) )
      // MAKE SURE THE OUTPUT IMG DOESN'T EXIST
{
      efio_FileUnlink(output, &lclerr); // DELETE IF EXIST
      EERR_CHECK(lclerr, EFS0("Error efio_FileUnlink"));
}

for (i = 1; i <= numbands; i++)
{
      layername = estr_Sprintf(NULL, "%s%s%d%s", &lclerr, output,
                                          "(:Band_", i, ")" );
      EERR_CHECK(lclerr, EFS0("Error creating the layer names!"));

      layer = eimg_LayerCreate (layername, imagetype, pixeltype,
```

```
                                        numcols, numrows,
                                        eint_GetInit(), &lclerr,
                              EIMG_LAYER_OPTION_COMPUTE_STATS_ON_CLOSE,
                                        EIMG_LAYER_OPTION_END);
            EERR_CHECK(lclerr, EFS0("Error creating the layer!"));

            /**** % METER % *****
            ** CHANGE TASK NAME
            ********************/
            emet_MeterInfoChangeTaskName(meter, layername, &lclerr);
            EERR_CHECK(lclerr, EFS0("Error emet_MeterInfoChangeTaskName!"));

            // READ ONE ROW AT ONE TIME
            for (j=0; j<numrows; j++)
            {
                  //READ FROM MDF BINARY
                  efio_ReadSeq (handle, pixelRect->data, (bytesperpixel*numcols),
                                    &lclerr);
                  EERR_CHECK(lclerr, EFS0("Error reading bytes file!"));

                  //WRITE TO IMG
                  eimg_LayerWrite (layer, 0, j, numcols, 1, pixelRect, &lclerr);
                  EERR_CHECK(lclerr, EFS0("Error writing buffer to IMG layer!"));

                  /**** % METER % *****
                  ** UPDATE METER
                  ********************/
                  emet_MeterInfoPrint(meter, (j*100)/(numrows), &lclerr);
                        EERR_CHECK(lclerr, EFS0("Error printing to the meter info!"));
            }
            eimg_LayerClose (layer, &lclerr);
            EERR_CHECK(lclerr, EFS0("Error closing active layer!"));
            layer = NULL;

      }


      /*
      **  WRITE MAP & PROJECTION INFO TO IMG
      */
      if (headerflag)
      {
            /**** % METER % *****
            ** CHANGE TASK NAME
            ********************/
            emet_MeterInfoChangeTaskName(meter, "Insert Map & Proj Info...", &lclerr);
            EERR_CHECK(lclerr, EFS0("Error emet_MeterInfoChangeTaskName!"));

            ReadHeader(input, output, &lclerr);
      }

      /*
      **  MARK SUCCESSFUL FINISH!!
      */
      rc = 0 ;

cleanup:
```

```
        if ( pixelRect )
        {
              eimg_PixelRectDelete(pixelRect, &lclerr);
              EERR_DELETE(lclerr);
              pixelRect = NULL;
        }

        if (handle)
        {
              efio_Close (handle, &lclerr);
              EERR_DELETE(lclerr);
              handle = NULL;
        }

        if ( layer )
        {
              eimg_LayerClose (layer, &lclerr);
              EERR_DELETE(lclerr);
              layer = NULL;
        }

        if ( meter )
        {
              emet_MeterInfoDelete( meter, &lclerr);
              EERR_DELETE(lclerr);
              meter = NULL;
        }

        return;
}
```

Code Explanation:

The emet package

The Progress Meter Support (**emet**) package allows an ERDAS IMAGINE application to report its progress in an extensible way. Placing calls to the emet package at critical points in a process allows a user to track the progress of an application.

---

emet_MeterInfoCreate ()

The prototype of this API is:

```
Emet_MeterInfo * emet_MeterInfoCreate( Etxt_Text taskname,
                          Etxt_Text metername,
                          Efio_Fd meterstream,
                                    Eerr_ErrorReport  errtn )
```

This function creates a structure for representing percentage done for a procedure. This function should be called after you have connected to the session manager or after you have initialized the EML toolkit. If you do the meter create before either of these two function calls, the dialog will not act as you predict.

NULL is returned if an error occurs while trying to create the structure. Otherwise, a pointer to the resulting **Emet_MeterInfo** structure is returned.

---

emet_MeterInfoSet ()

The prototype of this API is:

```
void emet_MeterInfoSet( Emet_MeterInfo *meterInfo,
                    double minPercentDone, double maxPercentDone,
                    Eerr_ErrorReport  inerrorreport )
```

This function resets the Emet_MeterInfo structure to map the range 0.0 through 100.0 linearly into **minPercentDone** through **maxPercentDone**.
The **minPercentDone** and **maxPercentDone** will range from 0.0 ~ 100.0.
We usually set **minPercentDone** to 0.0, and **maxPercentDone** to 100.0; For example, if you set the **minPercentDone** to 20.0 and **maxPercentDone** to 60.0, then the percent done displayed in the meter bar will start at 20%, and end at 60%.

---

emet_MeterInfoChangeTaskName ()

The prototype of this API is:

```
void emet_MeterInfoChangeTaskName( Emet_MeterInfo *meterinfo,
                                   Etxt_Text taskname,
                                   Eerr_ErrorReport  errtn )
```

This function changes the **taskname** (job state) for the specified meter.

---

emet_MeterInfoPrint ()

The prototype of this API is:

```
void emet_MeterInfoPrint( Emet_MeterInfo *meterinfo, double percentdone,
                          Eerr_ErrorReport  errtn )
```

This function displays the percentage complete.
You should provide the correct ***percentdone***, (range from 0.0~100.0).
In our example, the ***percentdone*** = (j*100)/(numrows)

```
emet_MeterInfoPrint(meter, (j*100)/(numrows), &lclerr);
      EERR_CHECK(lclerr, EFS0("Error error printing to the meter info!"));
```

This percentageDisplayed (always range from 0 ~ 100) is computed in the following manner:

$$percentDisplayed = \left(\frac{percentdone}{100} \right) \times \left(maxPercentDone - minPercentDone \right) + minPercentDone$$

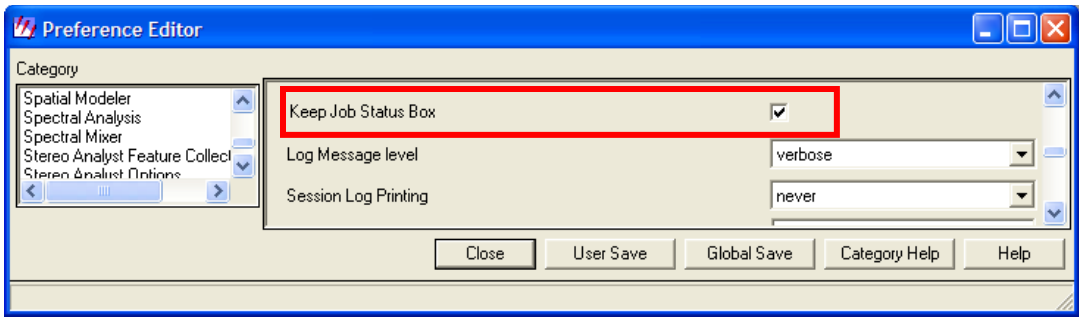
---

emet_MeterInfoDelete()

The prototype of this API is:

```
void emet_MeterInfoDelete(Emet_MeterInfo *meterinfo, Eerr_ErrorReport  errtn )
```

This function deletes a structure which had been created with the function **emet_MeterInfoCreate**. It checks user preferences to see if the dialog should remain on the screen before freeing the structure.
You may find this option from "**Preference->User Interface & Session->Keep Job Status Box**"; if you check this option, the meter bar will not disappear after job finished.



Class Notes:

Challenge 1: Use LayerStack to insert Map & Projection Info

Overview

In the previous section, you used **eimg_LayerMapInformationWrite()** and **eimg_LayerMapProctionWrite()** to insert map and projection information into layers. You had to write a loop in order to write the same map and projection information into all layers. In this challenge you will learn how to write the map and projection information into layers without using the loop. We will use the layerstack to achieve this:

Code Snippet (Ch5_08): Use layer stack to write Map & Projection Information

The old code: (using a loop)

```
/*
  INSERT MAP INFO & PROJECTION INFO BY LOOP
*/
inlayernames = eimg_LayerGetNames(outfile, erdInit, &lclerr);
EERR_CHECK(lclerr, EFS0("Error getting layer names of input file!"));

nlayers = inlayernames->count;
EERR_CHECK(nlayers < 1, EFS0("You didn't specify a valid input file!"));

for (i=0; i <nlayers; i++)
{
      inlayer = eimg_LayerOpen(inlayernames->strings[i], erdInit, &lclerr,
            EIMG_LAYER_OPTION_END);
      EERR_CHECK(lclerr, EFS1("Error opening layer #", i));

      /* INSERT MAP INFO */
      eimg_LayerMapInformationWrite( inlayer, projectionnamep, units,
            mapinfoXform, &lclerr );
         EERR_CHECK(lclerr, EFS1("Error writing map info structure to layer #", i));

      /* INSERT PROJECTION INFO */
      eimg_LayerMapProjectionWrite( inlayer, projinfo, &lclerr );
      EERR_CHECK(lclerr, EFS1("Error writing projection info structure \
                                    to layer #", i));

      eimg_LayerClose(inlayer, &lclerr);
      EERR_CHECK(lclerr, EFS1("Error closing layer #", i));
      inlayer = NULL;
```

```
}
```

The new code: (without loop)

```
/*
  OPEN LAYER STACK
*/
inlayernames = eimg_LayerGetNames(outfile, erdInit, &lclerr);
EERR_CHECK(lclerr, EFS0("Error getting layer names of input file!"));

inlayerstack = eimg_LayerStackOpen(inlayernames, erdInit, &lclerr,
      EIMG_LAYER_OPTION_END);
EERR_CHECK(lclerr, EFS0("Error p[ening layerstack!"));

/*
  INSERT MAP INFO & PROJECTION INFO BY LAYER STACK
*/
eimg_LayerStackMapInformationWrite(inlayerstack, projectionname, units,
      mapinfoXform,&lclerr);
EERR_CHECK(lclerr, EFS0("Error writing Map info to layerstack!"));

eimg_LayerStackMapProjectionWrite(inlayerstack, projinfo, &lclerr);
EERR_CHECK(lclerr, EFS0("Error writing projection info to layerstack!"));
```

Code Explanation:

eimg_LayerStack*()

---

eimg_LayerStackOpen ()

The prototype of this API is:

```
Eimg_LayerStack * eimg_LayerStackOpen( Eimg_LayerNameStack     *totalNames,
      Eint_InitToolkitData     *erdInit,
      Eerr_ErrorReport     inerr,
      va_dcl)
```

This function opens the existing layers indicated by the character string list **totalNames**. It additionally sets up and returns an **Eimg_LayerStack** structure to be used by the eimg functions in the processing these layers.

Note:

1. All layers will have the same dimensions, pixel type, layer types, and attributes as specified via the variable-length argument list.
2. The last item in the argument list for this function must be **EIMG_LAYER_OPTION_END**.
3. All options which may appear in the variable-length argument for the function **eimg_LayerOpen** may also appear in this function.

NULL is returned if an error occurs while trying to create the **Eimg_LayerStack** structure. Otherwise, a pointer to the resulting **Eimg_LayerStack** structure is returned.

eimg_LayerStackMapInformationWrite ()

The prototype of this API is:

```
void eimg_LayerStackMapInformationWrite( Eimg_LayerStack       *layerStack,
                    Etxt_Text            proName,
                    Etxt_Text            units,
                    Exfr_XForm      *xForm,
                    Eerr_ErrorReport      inerr)
```

This function writes map information to be associated with the specified **Eimg_LayerStack** ***layerStack***, Any previously existing map information will be overwritten. This function will not remove any existing Projection informaton. It is the caller's responsibility to ensure that the projection information associated with the layers in the layer stack is consistent with the map information associated with the layers in the layer stack.

proName, ***units***, ***xForm*** must be either all NULL or all non-NULL. If they are all non-NULL, the map information contained in the parameters will be written the layer. If they are all NULL, any map information associated with the layer will be deleted.

proName contains a projection name which identifies the map system of the layer. This may be the eprj_ProjectionNameUnknown.

units contains the map units upon which *xForm* is based.

xForm contains the map to layer pixel transformation for the layer.

eimg_LayerStackMapProjectionWrite ()

The prototype of this API is:

```
void eimg_LayerStackMapProjectionWrite( Eimg_LayerStack   *layerStack,
                    Eprj_MapProjection   *projection,
                    Eerr_ErrorReport      inerr)
```

This function associates a map projection, ***projection,*** with an **Eimg_LayerStack**, *layerStack*. This map projection describes the earth to map system transformation for the map system associated with the layer. If you want to remove the map and projection information from the layer you need to set the ***projection*** to NULL,

Class Notes:

Section 6: Application Function DLL

Section objective:

This section introduces the basics of IMAGINE DLL technologies, and walks you through the creation of an application function dll, which will extend the functionality of your EML.

Packages used:

edll

Understand IMAGINE Plug-in DLL Technology

IMAGINE Plug-in DLL Technology

In architecting systems that deliver customization options to end users, the creation of application programs which can be extended without recompiling or relinking becomes a highly desired goal. The shared library technology in a UNIX system and the dynamically linked library technology in a Windows system is used to develop applications which access code from libraries.

Load DLLs at load time vs. at run time

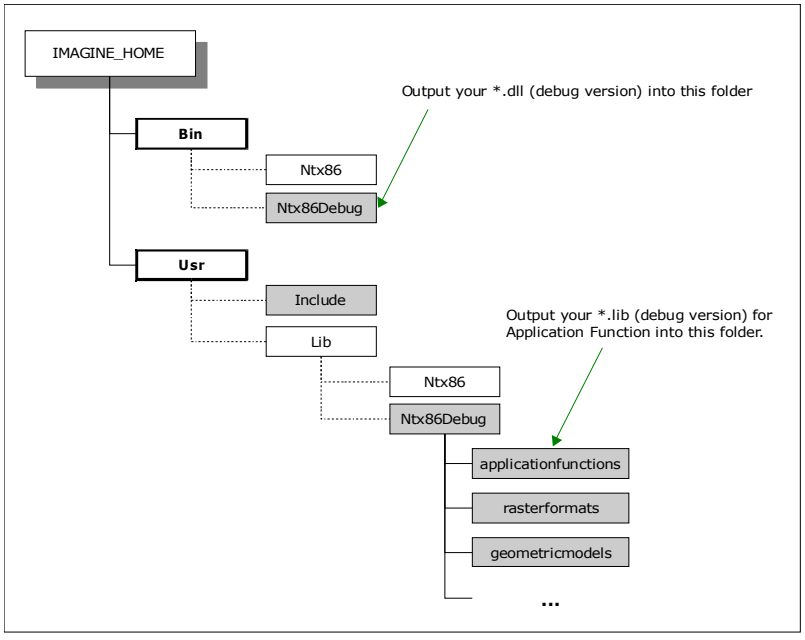
The libraries can be loaded at the time the application is loaded or at the runtime when they are needed. Core IMAGINE libraries (i.e**., eraster.dll, elib.dll, viewlib.dll, emllib.dll**...) will be loaded into memory in the IMAGINE startup time.

The plug-in DLLs will be loaded into memory at runtime when they are needed.

How Plug-in DLLs works

IMAGINE plug-in DLLs can be categoried into different classes by their ususage; you may create plug-in DLL instances for each class. The creation of all plug-in DLL class must follow the standard rule defined by IMAGINE; we will learn an application function dll template in the next exercise.

After create the plug-in DLLs, just copy the ***.dll**, ***.lib** into the destination folder, shown below in grey.

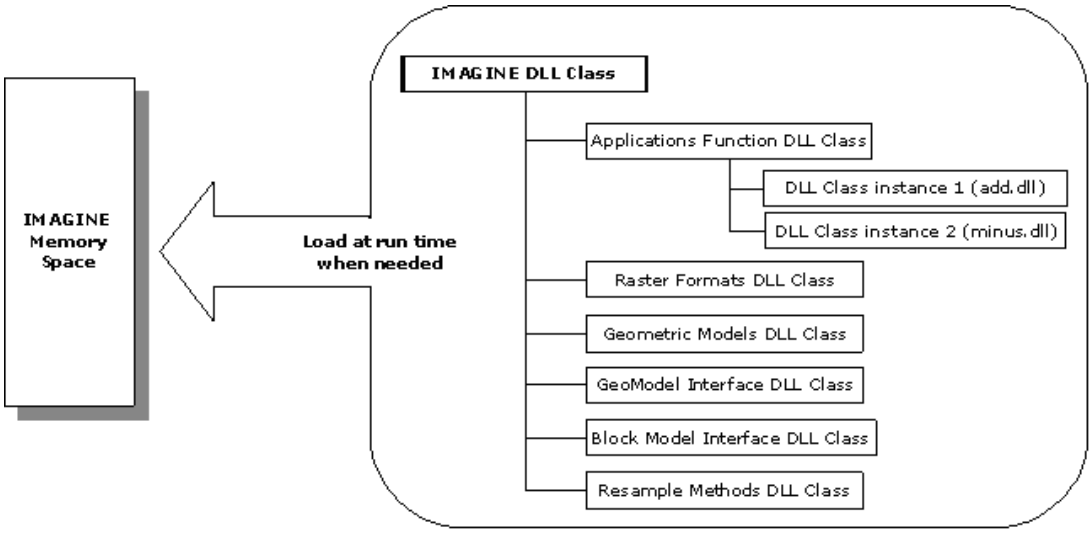


You may also refer to IMAGINE environment variable for other locations, there is an environment variable for each IMAGINE DLL class, you may find them from session->properties; for example:

```
ERDAS_APPLICATION_FUNCTIONS_PATH
ERDAS_BLOCKMODEL_INTERFACES_PATH
ERDAS_GEOMETRIC_MODELS_PATH
ERDAS_GEOMODEL_INTERFACES_PATH
ERDAS_RASTER_FORMATS_PATH
ERDAS_RESAMPLE_METHODS_PATH
```

Now you need to run IMAGINE's reconfiguration tool (Session->Utilities) to search the plug-in DLL folder and update the ***.cfg** file. The ***.cfg** file keep all the updated information about plug-in dlls, which enable IMAGINE to locate plug-in dlls. You may find *.cfg from **C:\Documents and Settings\All Users\Application Data\ERDAS\ERDAS Desktop 2011\devices\Win32Release** folder (C:\ProgramData\ERDAS\ERDAS Desktop 2011\devices\Win32Release for 64bit system) or **<IMAGINE_HOME>\device\Win32Release** folder for IMAGINE 9.x.

After the reconfiguration IMAGINE can automatically integrate plug-in DLLs into IMAGINE framework at runtime, there is no need to recompile IMAGINE. IMAIGNE will locate and open a DLL by name at runtime when this DLL is needed.


IMAGINE DLL Class
Applications Function DLL Class
DLL Class instance 1 (add.dll)
DLL Class instance 2 (minus.dll)
Raster Formats DLL Class
Geometric Models DLL Class
GeoModel Interface DLL Class
Block Model Interface DLL Class
Resample Methods DLL Class
IMAGINE Memory Space
Load at run time when needed

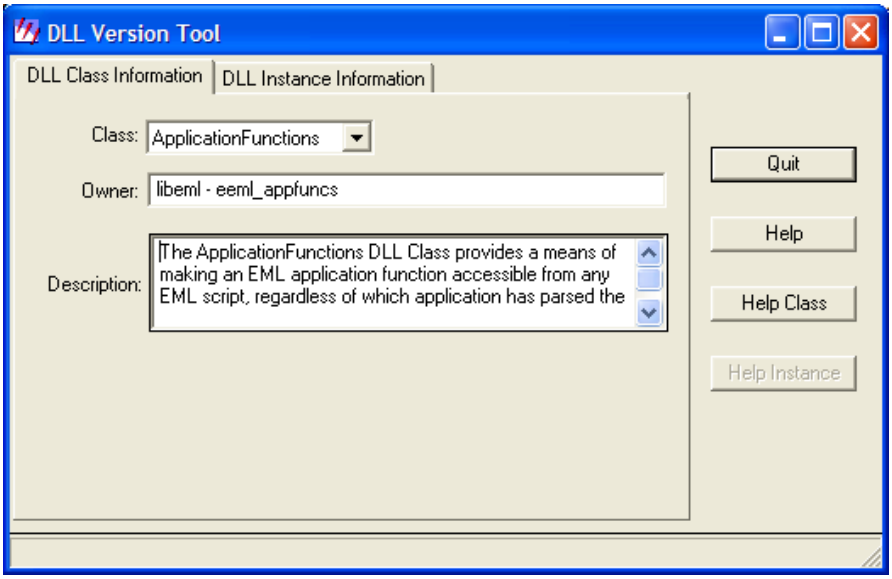
***Note**: there is no reconfiguration tool for "application functions dll", because IMAGINE will load all application functions dlls into the memory space when excuting "**eeml_Init()**".*

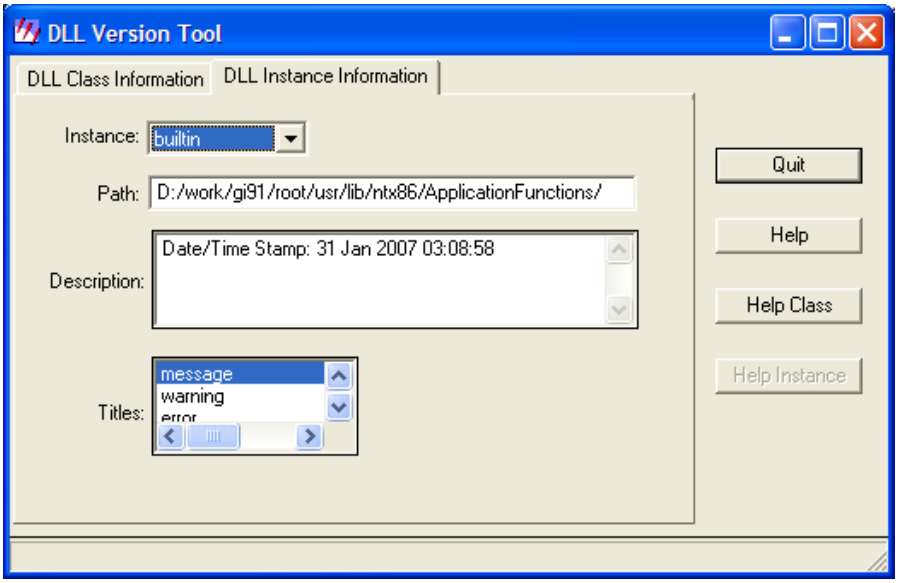
Benifit of Plug-in DLLs

The Plug-in DLLs can save the memory usuage, and also extend IMAGINE without recompiling IMAGINE.

DLL Version Tool

IMAGINE's DLL Version Tool (Session->Help->IMAGINE DLL Information), will provide an easy way to look at basic descriptions and functions about plug-in DLLs. It reads the ***.cfg** file to populate the information.





Application Function DLL

The **ApplicationFunctions** DLL class provides a means of defining functions callable from within EML scripts on a session-wide basis.

The initial specifications of EML defined built-in functions that are callable from any EML script regardless of the application that parsed the EML script. These functions are defined in the EML library that EML based applications rely on for their EML script interpreting ability. Though ccessible session-wide, this list of functions is not easily extensible.

Later specifications allowed this list of functions that were callable from within an EML script to be extended by allowing a function translation table to be supplied by an application to the EML library routine that parses an EML script for interpretation. Although this provided extensibility, the added functions were only usable from EML scripts that were parsed by the application that defined the functions.

The **ApplicationFunctions** DLL Class allows functions to be introduced to an IMAGINE installation that are available session-wide. These functions can be called from any EML script, regardless of the application that is used to parse that EML script.

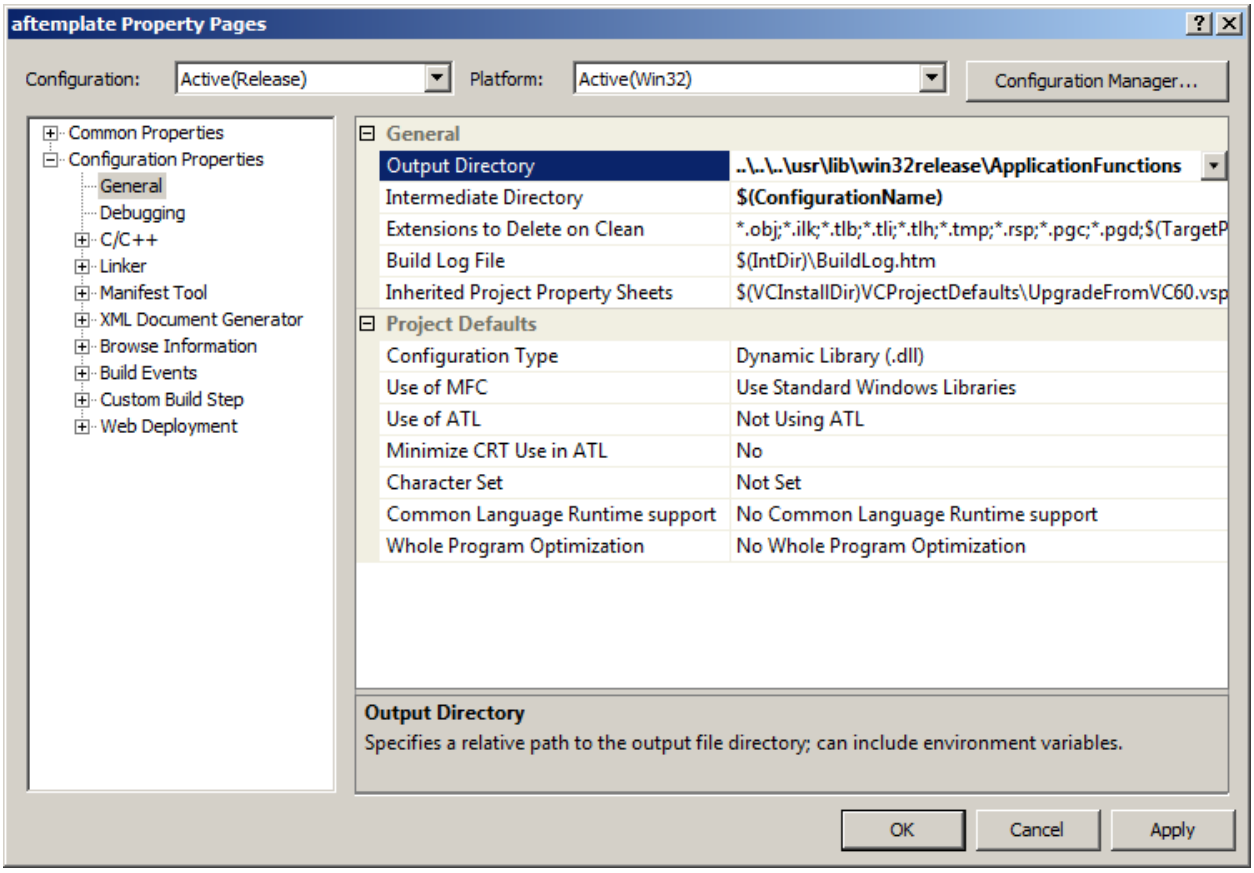
The following instances of ApplicationFunctions DLLs are distributed with the current version of IMAGINE.

DLL Instances	Description
builtin.dll	Application functions built-in to EML

Setup Microsoft Visual Studio 2008

In order to compile plug-in DLLs you need to change a few settings for your Visual Studio 2008.

Configuration Properties->General



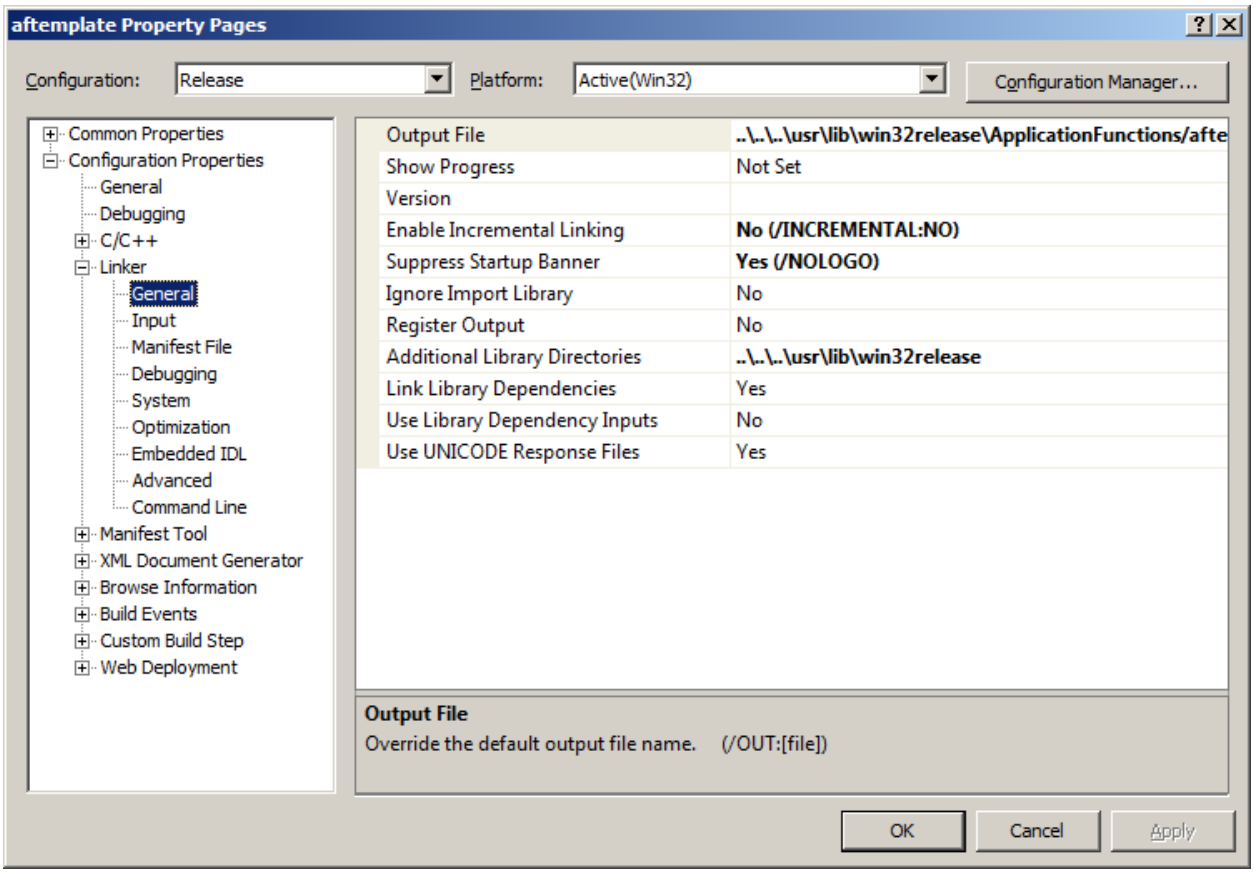
Change the output directory to the following:

```
Output Directory:
.\..\..\usr\lib\Win32Release\ApplicationFunctions
```

Change the Configuration Type to the following:

```
Configuration Type:
Dynamic Library (.dll)
```

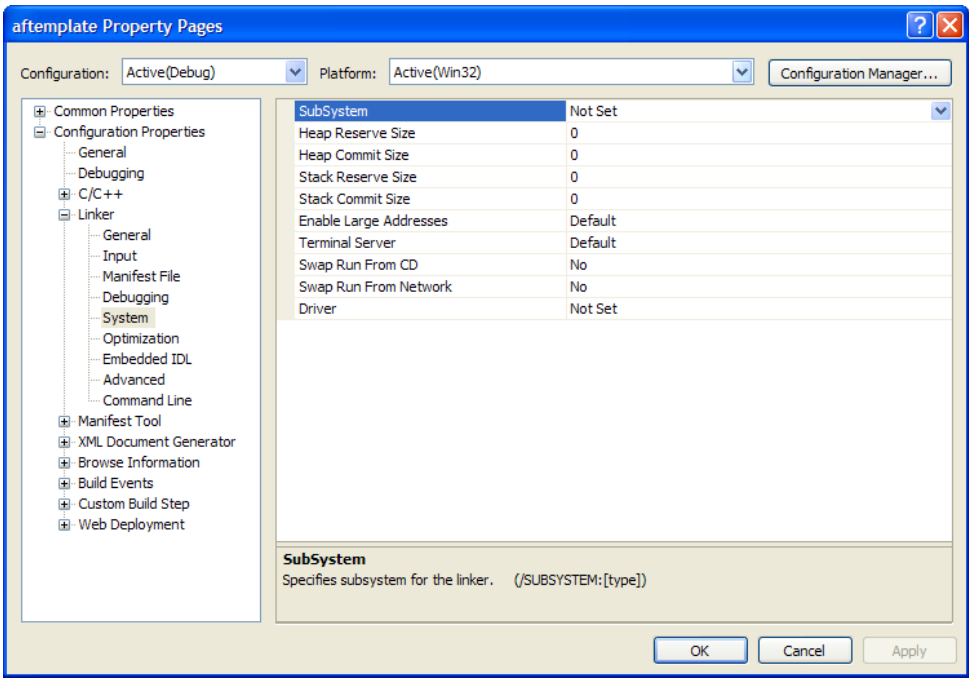
Configuration Properties->Linker->General



Change the output directory to the following:

```
Output File:
.\..\..\usr\lib\Win32Release\ApplicationFunctions/$(InputName).dll
```

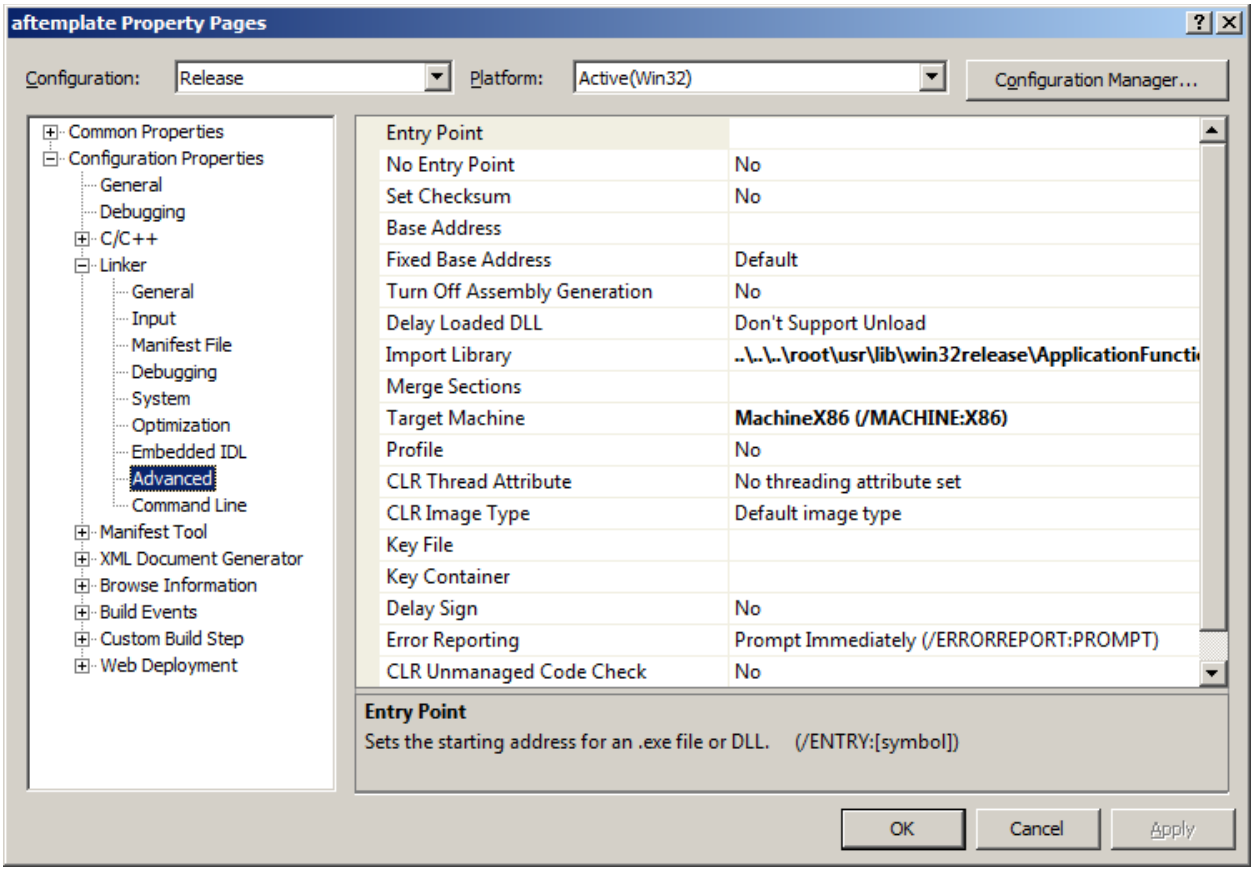
Configuration Properties->Linker->System



Change the subsystem to the following:

```
SubSystem:
Not Set
```

Configuration Properties->Linker->Advanced



Change the output directory to the following:

```
Output File:
.\..\..\usr\lib\Win32Release\ApplicationFunctions/$(InputName).lib
```

Class Notes:

Exercise 1: An Application Function DLL Template

Exercise Objective:

In this exercise, we will create a template for Application Function DLL, you will be able to modify this template for the future exercises.

Packages used:

edll

What this Application Function DLL Tempalte does

This template will create an application function dll called "**aftemplate.dll**", which includes three dummy EML functions (i.e., **function1(), function2(), functionetc()**).

Application function dlls use the IMAGINE plug-in DLL technology, so that the dll can be loaded when called from an EML (since the purpose of the application function dll is to extend EML functionality).

EML is used for creating the IMAGINE GUI interface. After you modify or add dlls the next time you restart IMAGINE, IMAGINE will automatically re-scan the **<IMAGINE_HOME>\usr\lib\Win32Release\applicationfunctions** folder and load all application function dlls (including modified or new) into memory.

There are three places where the function name appears and you need to make sure the same name is used. For example, the "**function1**" will appear in the following three places:

<1>

```
APP_FUNC( function1 ); /* and Edit this */
APP_FUNC( function2 ); /* and Edit this */
APP_FUNC( functionetc ); /* and Edit this */
```

<2>

```
static char *Titles[] = {
    "function1", /* and Edit this */
    "function2", /* and Edit this */
    "functionetc" /* and Edit this */
};
```

<3>

```
APP_FUNC( function1 ) /* and Edit this */
{
    EERR_INIT("function1", outerr, lclerr );
    Estr_StringList *result = NULL;

    /*
      Fill in the logic here
    */

cleanup:
    EERR_SHOW(lclerr, EERR_DEBUG);
    return result;
}
```

Make sure the three "function#" match the same name;

For Example:
If you want to change the name "`function1`", you need to change all the three places.

Application Functions & APP_FUNC Macro

Each of the application functions should have the following prototype:

```
Estr_StringList *appFunc __((
      Eeml_Menu menu,         /* Unused */
      Emsc_Opaque *context,   /* Function Context */
      long argc,              /* Argument Count */
      char  argv,             /* Argument List */
      Eerr_ErrorReport  err));
```

When the application function is called each of the arguments is converted to a string and passed in via the argv. The number of arguments is contained in argc. Additionally, the context argument is a pointer to user defined data which is defined as the appdata in the **eeml_ParseVa** call.

In the next example, you will see Macro **APP_FUNC**. This macro will simplify the function exportation in dll.

APP_FUNC

The prototype of this Macro is:

```
#define APP_FUNC(fName)                                  \
DllExport Estr_StringList *                              \
IFD_NAME(fName)(                                         \
    Eeml_Menu menu,                                 \
    Emsc_Opaque *context,                                \
    long argc,                                      \
    char  argv,                                          \
    Eerr_ErrorReport  outerr                             \
)
```

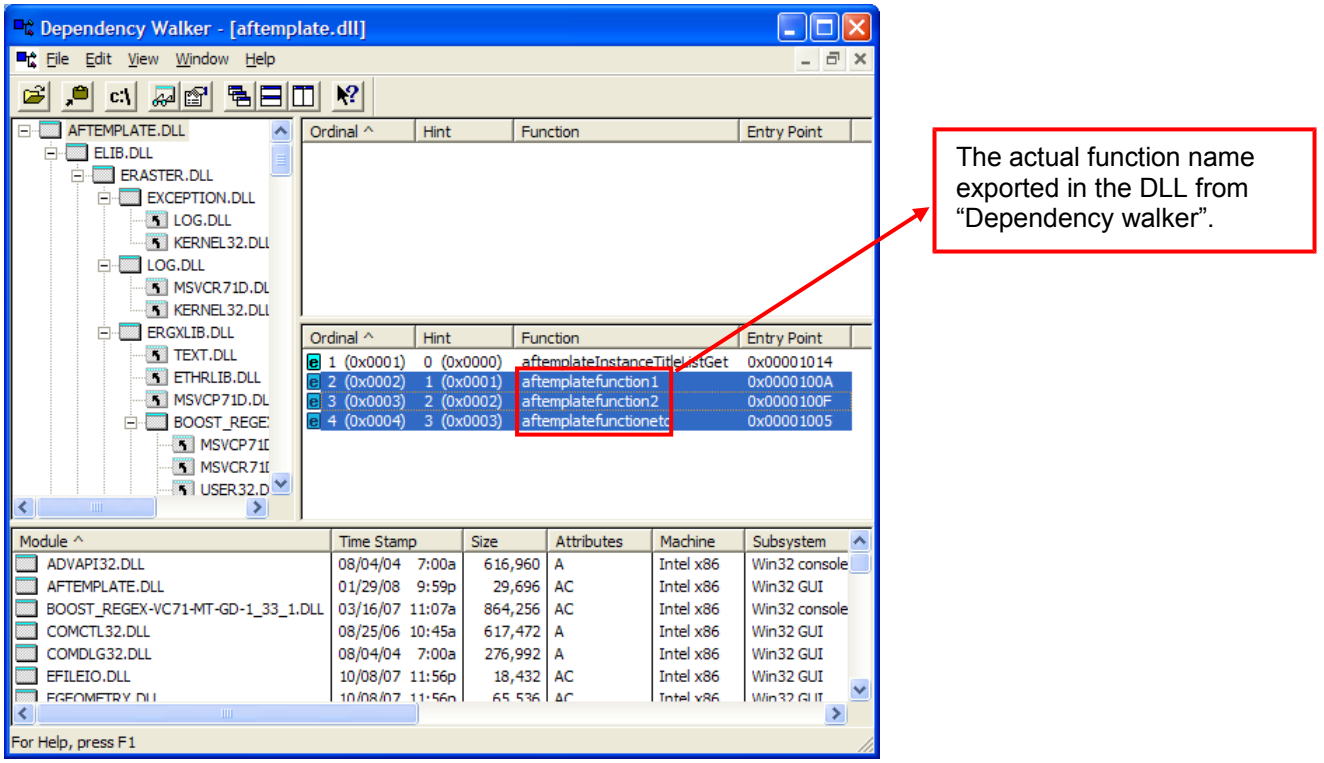
This macro will actually combine the **DLL_INSTANCE_NAME** with the function name as the final function name.

```
#define   DLL_INSTANCE_NAME aftemplate

APP_FUNC(function1)
APP_FUNC(function2)
APP_FUNC(functionetc)
```

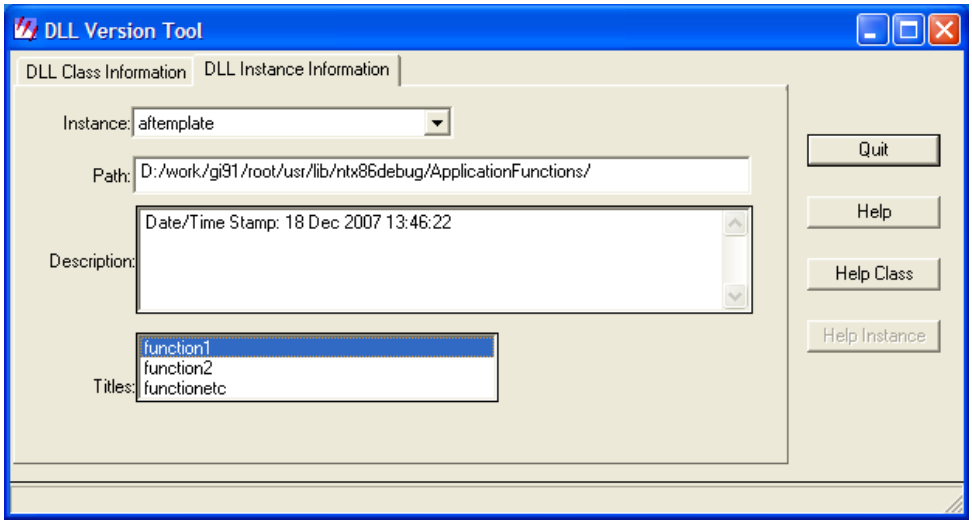
This is what you will see in the Preprocessed file (i.e., ***.i**) file.

```
__declspec( dllexport ) Estr_StringList * aftemplatefunction1( Eeml_Menu menu,
Emsc_Opaque *context, long argc, char  argv, Eerr_ErrorReport  outerr );
__declspec( dllexport ) Estr_StringList * aftemplatefunction2( Eeml_Menu menu,
Emsc_Opaque *context, long argc, char  argv, Eerr_ErrorReport  outerr );
__declspec( dllexport ) Estr_StringList * aftemplatefunctionetc( Eeml_Menu
menu, Emsc_Opaque *context, long argc, char  argv, Eerr_ErrorReport  outerr );
```

Note that you have to change the **DLL_INSTANCE_NAME** to be the same base name of your DLL. In our case, the output dll is called **aftemplate.dll**, the **DLL_INSTANCE_NAME** should change to **aftemplate**. If this rule is not followed IMAGINE will not be able to find the current titlelist in **aftemplate.dll**.


Dependency Walker - [aftemplate.dll]
File Edit View Window Help
AFTEMPLATE.DLL
ELIB.DLL
ERASTER.DLL
EXCEPTION.DLL
LOG.DLL
KERNEL32.DLL
LOG.DLL
MSVCR71D.DL
KERNEL32.DLL
ERGXLIB.DLL
TEXT.DLL
ETHRLIB.DLL
MSVCP71D.DL
BOOST_REGE
MSVCP71
MSVCR71
USER32.D
Ordinal ^ Hint Function Entry Point
1 (0x0001) 0 (0x0000) aftemplateInstanceTitleListGet 0x00001014
2 (0x0002) 1 (0x0001) aftemplatefunction1 0x0000100A
3 (0x0003) 2 (0x0002) aftemplatefunction2 0x0000100F
4 (0x0004) 3 (0x0003) aftemplatefunctionetc 0x00001005
Module ^ Time Stamp Size Attributes Machine Subsystem
ADVAPI32.DLL 08/04/04 7:00a 616,960 A Intel x86 Win32 console
AFTEMPLATE.DLL 01/29/08 9:59p 29,696 AC Intel x86 Win32 GUI
BOOST_REGEX-VC71-MT-GD-1_33_1.DLL 03/16/07 11:07a 864,256 AC Intel x86 Win32 console
COMCTL32.DLL 08/25/06 10:45a 617,472 A Intel x86 Win32 GUI
COMDLG32.DLL 08/04/04 7:00a 276,992 A Intel x86 Win32 GUI
EFILEIO.DLL 10/08/07 11:56p 18,432 AC Intel x86 Win32 GUI
For Help, press F1
The actual function name exported in the DLL from "Dependency walker".

The above diagram shows what it looks like when load the **aftemplate.dll** into the "Dependency Walker" program. You will find that the name displayed in the "Function" column is not the actual function name used to call from EML.



From the IMAGINE DLL Version Tool (shown above), you will find the actual function names (i.e., **function1**, **function2**, and **functionetc**) defined by the "Title[]" string shown below.

```
static char *Titles[] = {
            "function1", /* and Edit this */
            "function2", /* and Edit this */
            "functionetc" /* and Edit this */
       };
```

Code Snippet (Sec6_01) : aftemplate.c

```
/*************************************************************************
*************************************************************************
 Application Function: appFuncTemplate

 Purpose: This DLL will <functions of this dll>.

 Calling syntax:

  function1(parm1, parm2, ...)
  function2(parm1, parm2, ...)
  functionetc(parm1, parm2, ...)

 Input Parameters: None
 Return Values: A string list

 Notes:
 This ApplicationFunctions DLL is loaded when ERDAS IMAGINE is
 started.  It provides functions that are available to every EML
 script.

 This template is the outline for how an ApplicationFunctions DLL is to
 be set up.  All application functions are called from within an EML
 script. A string list is returned back to the eml script.

 Important Note: Be aware of the order in which you add things to the
 stringlist. When EML receives a string list with the first value
 numeric then it will take all the elements to be numbers and it won't
 return any characters. If the first is a character then it will take
 everything to be a character and it will return everything even
 numbers. You won't be able to perform arithmetic on those numbers
 since they will actually be characters.
*************************************************************************
*************************************************************************/

/*
** STANDARD INCLUDES
*/
#include <stdio.h>

/*
```

```
** TOOLKIT INCLUDES
*/
#include <eint.h>
#include <eerr.h>
#include <eeml.h>
#include <emsc.h>
#include <eimg.h>
#include <erga.h>

/*
** DEFINITION OF INSTANCE
**    CHANGE DLL_INSTANCE_NAME TO BE THE SAME AS THE BASE NAME OF YOUR DLL
**    FOR SOMETHING.DLL, DLL_INSTANCE_NAME SHOULD BE SOMETHING.
**    OTHERWISE, IMAGINE WILL NOT FIND YOUR DLL.
*/
#define     DLL_INSTANCE_NAME aftemplate

/*
**    THIS MUST COME AFTER THE #DEFINE DLL_INSTANCE_NAME MDF LINE
**    AS IT REQUIRES THE THE DLL_INSTANCE_NAME TO ALREADY BE SET
*/
#include <edll.h>

/*
** DEFINITION OF ERROR CHECKING MACROS
*/
#define EFS1( msg, arg ) EERR_FATAL_SET_1( __LINE__, msg, arg )
#define EFS0( msg ) EERR_FATAL_SET_0( __LINE__, msg )
#define ES0( e, msg ) EERR_SHOW_0( e, EERR_DEBUG, __LINE__, msg )

/*
** DEFINITION OF APPLICATION FUNCTION MACRO
**    This APP_FUNC macro will prototype and define application
**    functions exported by the DLL.  IFD_NAME prepends the DLL
**    instance name to the application function name, which is
**    a requirement for all ApplicationFunction DLLs.
*/
#define APP_FUNC(fName)                                     \
DllExport Estr_StringList *                                 \
IFD_NAME(fName)(                                            \
      Eeml_Menu menu,                                       \
      Emsc_Opaque *context,                                 \
      long argc,                                            \
      char **argv,                                          \
      Eerr_ErrorReport **outerr                             \
)


/*
** PROTOTYPE(S) OF THE FUNCTION(S) EXPORT BY THIS DLL
**    Give your functions logical names that identify what
**    they do, but avoid names already defined by EML.
*/
APP_FUNC(function1); /* and Edit this */
APP_FUNC(function2); /* and Edit this */
APP_FUNC(functionetc); /* and Edit this */


/*
** SPECIFY THE EML NAME(S) OF THE FUNCTION(S) SUPPLIED BY THIS DLL
**    You should call the following function name in EML.
```

```
*/
static char *Titles[] = {
      "function1", /* and Edit this */
      "function2", /* and Edit this */
      "functionetc" /* and Edit this */
};


/*
** THIS FUNCTION TELLS EML THE NAME(S) OF THE
** FUNCTION(S) SUPPLIED BY THIS DLL
*/
DllExport long
IFD_NAME(InstanceTitleListGet)(
      unsigned long *count,
      char ***titleList
)
{
      long titleCount = sizeof(Titles)/sizeof(char*);

      *titleList = emsc_New(titleCount, char *);
      if(*titleList)
      {
            for(*count = 0; *count < titleCount; (*count)++)
            {
                  (*titleList)[*count] = estr_Duplicate(Titles[*count]);
            }
      }
      return 0;
}


/*
** DEFINE APPLICATION FUNCTIONS
**    Define each of the ApplicationFunctions supplied by this DLL.
**    It can take input parameters (argc,argv) and may return a
**    string list with the result(s) of the function.
*/

APP_FUNC(function1) /* and Edit this */
{
      EERR_INIT("function1", outerr, lclerr );
      Estr_StringList *result = NULL;

      /*
      ** Fill in the logic here
      */

cleanup:

      EERR_SHOW(lclerr, EERR_DEBUG);
      return result;
}


APP_FUNC(function2) /* and Edit this */
{

      EERR_INIT("function2", outerr, lclerr );
      Estr_StringList *result = NULL;
```

```
	/*
	** Fill in the logic here
	*/

cleanup:

	EERR_SHOW(lclerr, EERR_DEBUG);
	return result;
}


APP_FUNC(functionetc) /* and Edit this */
{
	EERR_INIT("functionetc", outerr, lclerr );
	Estr_StringList *result = NULL;

	/*
	** Fill in the logic here
	*/

cleanup:

	EERR_SHOW(lclerr, EERR_DEBUG);
	return result;
}
```

Code Explanation:

InstanceTitleListGet()

The **InstanceTitleListGet()** function will also be exported in the DLL, and it will enable IMAGINE to get function titles quickly.

This list of titles returned from **InstanceTitleListGet()** is interpreted as a list of function names of global **Eeml_AppFunction**'s accessible in the DLL instance from which the list was obtained. If a given title is located as a global function symbol, a pointer to that function is placed in the translation table of the EML library. Otherwise, the title is ignored. Any given title must currently name an **Eeml_AppFunction** or the argument passing from the EML script to the function will not occur properly.

InstanceTitleListGet()

The prototype of this API is:

```
long InstanceTitleListGet(
	unsigned long *count, /* Output */
	char  *titleList /* Output */
)
```

The **InstanceTitleListGet** function is used to query a DLL for titles of objects or methods that are serviced by that DLL. The results of this function are intended to be used ultimately by user

interface software so that appropriate title lists can be constructed and presented to the user based solely on what sort of input a particular interface is looking for and what DLLs are available.

This function should set *** titleList** to a character string list of all titles (objects or methods) supported by this DLL. The string list should be dynamically allocated so as to be freeable by the caller. The individual strings in the string list should also be freeable by the caller. The count of the strings in the list should be placed in *** count**.

Class Notes:

Exercise 2: Add Function to EML (CountPixel)

Exercise Objective:

In this exercise, we will create an Application Function DLL, which allow you to count the occurence of certain pixel value in an IMAGINE **(*.img**) file.

Packages used:

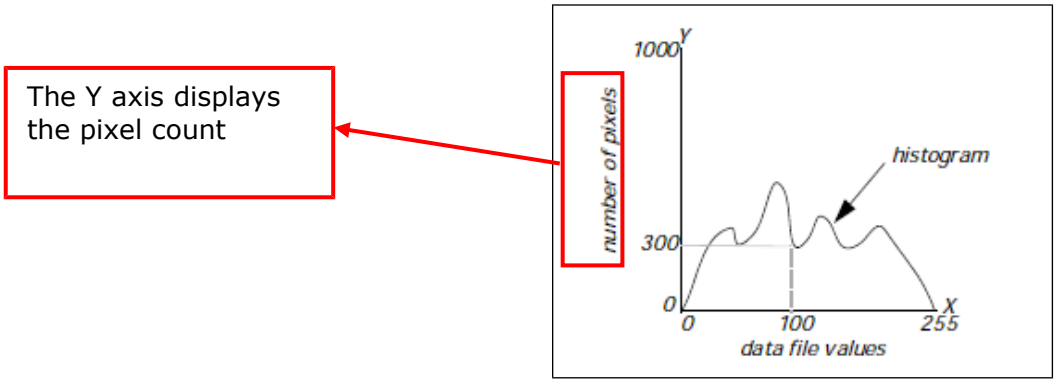
eint
eerr
eeml
edll
eimg
erga

What this Application Function DLL does

In this exercise, we will create an application function dll (i.e., **pixelcount.dll**), which will contain the EML function **pixelcount()**. This function will count the occurence of certain pixel value in an image layer.

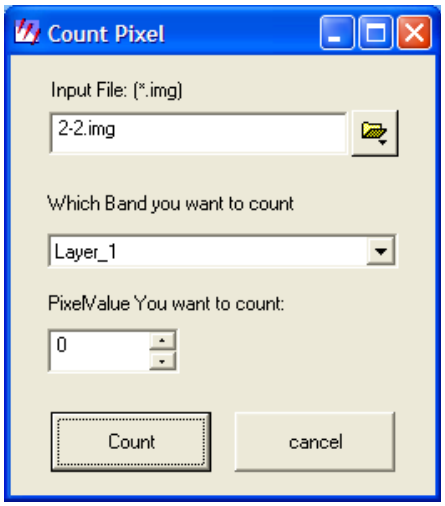
You can use a double loop to count the occurrence of certain pixel value, but this may be very slow, based on the image size. In this exercise, you will use a histrogram to directly get the pixel count. This method, of getting a pixel count, is much faster than using the double loop method.

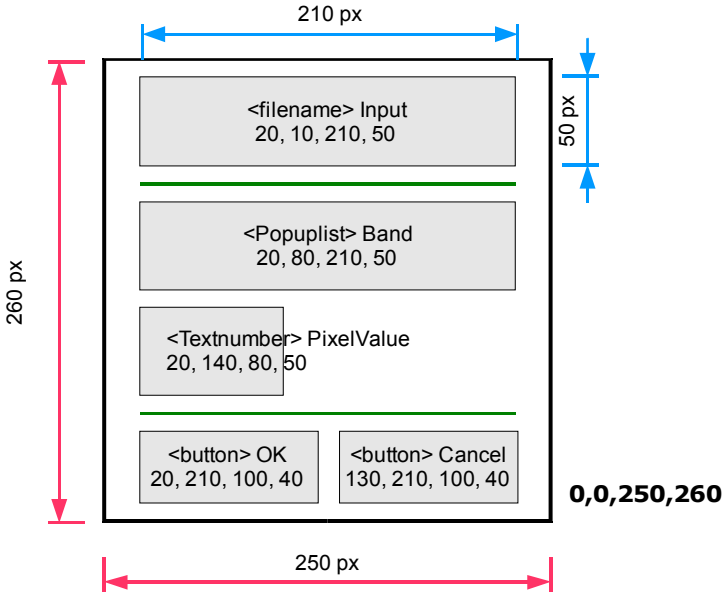
The following figure shows how a histogram displays number of pixels. e.g., there is 300 pixels with pixel value 100.



Design the GUI

In order to test this application function dll, we need to set up an EML script that will call the function from application function dll.


Count Pixel
Input File: (*.img)
2-2.img
Which Band you want to count
Layer_1
PixelValue You want to count:
0
Count
cancel


210 px
50 px
260 px
<filename> Input
20, 10, 210, 50
<Popuplist> Band
20, 80, 210, 50
<Textnumber> PixelValue
20, 140, 80, 50
<button> OK
20, 210, 100, 40
<button> Cancel
130, 210, 100, 40
0,0,250,260
250 px

Code Snippet (Sec6_02) : pixelcount.c

```
/*****************************************************************************
******************************************************************************
 APPLICATION FUNCTION: pixelcount

 PURPOSE: THIS DLL WILL <FUNCTIONS OF THIS DLL>.

 CALLING SYNTAX:
  set num = pixelcount($inputfilename,$Bandlvalue,$pixelvalue)

 INPUT PARAMETERS: inputfilename, bandvalue, pixelvalue

 RETURN VALUES: The number of occurence of certain pixelvalue.

******************************************************************************
*****************************************************************************/

/*
** STANDARD INCLUDES
*/
#include <stdio.h>

/*
** Toolkit Includes
*/
#include <eint.h>
#include <eerr.h>
#include <eeml.h>
#include <emsc.h>
#include <eimg.h>
#include <erga.h>

/*
** DEFINITION OF INSTANCE
*/
#define     DLL_INSTANCE_NAME pixelcount

/*
**    THIS MUST COME AFTER THE #DEFINE DLL_INSTANCE_NAME MDF LINE
**    AS IT REQUIRES THE THE DLL_INSTANCE_NAME TO ALREADY BE SET
*/
#include <edll.h>

/*
** DEFINITION OF ERROR CHECKING MACROS
*/
#define EFS1( msg, arg ) EERR_FATAL_SET_1( __LINE__, msg, arg )
#define EFS0( msg ) EERR_FATAL_SET_0( __LINE__, msg )
#define ES0( e, msg ) EERR_SHOW_0( e, EERR_DEBUG, __LINE__, msg )

/*
** DEFINITION OF APPLICATION FUNCTION MACRO
*/
#define APP_FUNC(fName)                         \
DllExport Estr_StringList *                     \
IFD_NAME(fName)(                                 \
    Eeml_Menu menu,                              \
```

```
    Emsc_Opaque *context,                       \
    long argc,                                   \
    char **argv,                                 \
    Eerr_ErrorReport **outerr                   \
)

/*
** PROTOTYPE(S) OF THE FUNCTION(S) SUPPLIED BY THIS DLL.
** GIVE YOUR FUNCTIONS LOGICAL NAMES THAT IDENTIFY WHAT
** THEY DO, BUT AVOID NAMES ALREADY DEFINED BY EML.
*/
APP_FUNC(pixelcount); /* and Edit this */

/*
** SPECIFY THE EML NAME(S) OF THE FUNCTION(S) SUPPLIED BY THIS DLL
*/
static char *Titles[] = {
      "pixelcount" /* and Edit this */
};

/*
** THIS FUNCTION TELLS EML THE NAME(S) OF THE
** FUNCTION(S) SUPPLIED BY THIS DLL
*/
DllExport long
IFD_NAME(InstanceTitleListGet)(
    unsigned long *count,
    char ***titleList
)
{
    long titleCount = sizeof(Titles)/sizeof(char*);

      *titleList = emsc_New(titleCount, char *);
      if(*titleList)
      {
            for(*count = 0; *count < titleCount; (*count)++)
            {
                  (*titleList)[*count] = estr_Duplicate(Titles[*count]);
            }
      }
    return 0;
}


/*
** DEFINE EACH OF THE APPLICATIONFUNCTIONS SUPPLIED BY THIS DLL.
** It can take input parameters (argc,argv) and may return a
** string list with the result(s) of the function.
**    argv[0] = pixelcount
**    argv[1] = "bandvalue"
**    argv[2] = "pixelvalue"
*/
APP_FUNC(pixelcount) /* and Edit this */
{

      /*
      ** LOCAL DEFINITIONS OF VARIABLES
      */
      int         i = 0;
      long  numOfPixels, numOfLayers = 0;
      long  bandVal, pixVal;  //FOR INPTUT ARGUMENT
```

```
long  numBins = 0;
long  statsSkipFactorX;
long  statsSkipFactorY;
Estr_StringList *      layernames = NULL;
Egda_PixelType               pixelType;
Eimg_Layer  *                layer = NULL;
Eimg_LayerStack *      layerStack = NULL;
Esta_AllStatsStack *   allStatStack = NULL;
Erga_DefaultBinfStruct binFunc;
Edsc_BinFunctionType   binType;
Estr_StringList *      returnList =(Estr_StringList *) NULL;

EERR_INIT("PixelCount", &lclerr, lclerr );


/*
** MAKE SURE THERE IS 3 INPUT ARGUMENTS
*/
if (argc != 3)
{
      esmg_LogMessage(ESMG_LOG_TERSE, &lclerr, "\n PixelCount: Should be 3 \
            arguments, but %d arguments given\n", argc);
      for (i = 0; i < argc; i++) printf("Inparameter: %d: %s\n", i, argv[i]);
      // RETURN -2 BACK TO EML
      numOfPixels = -2;
      return estr_LongToStringList(1, &numOfPixels,&lclerr);
}


/*
** GET INPUT BANDVALUE AND PIXELVALUE
*/
bandVal = etxt_Text_atol(argv[1]) ; /* C array starts with zero,
                                       the input band index also starts from zero */
pixVal = etxt_Text_atol(argv[2]);


/*
** GET ALL LAYER NAMES
*/
layernames = eimg_LayerGetNames(argv[0], eint_GetInit(), &lclerr);
EERR_CHECK(lclerr, EFS0("Error eimg_LayerGetNames"));

numOfLayers = layernames->count;


/*
** OPEN ALL LAYERS
*/
layerStack = eimg_LayerStackOpen(layernames,eint_GetInit(), &lclerr,
      EIMG_LAYER_OPTION_END);
EERR_CHECK(lclerr, EFS0("Error eimg_LayerStackOpen"));


/*
** GET IMAGE STATISTICS IF IT ALREADY HAVE ONE
**    i.e., BIN TYPE, SKIP FACTOR..
*/
layer = layerStack->layers[0];
binType = layer->table ->binFunction->binFunctionType; //EDSC_DIRECT_BINS
statsSkipFactorX = layer->statsSkipFactorX ;
```

```
statsSkipFactorY = layer->statsSkipFactorY ;
pixelType = layer->pixelType;

/*
** FREE LAYERSTACK MEMORY AREA
*/
eimg_LayerStackClose(layerStack, &lclerr);
EERR_CHECK(lclerr, EFS0("Error eimg_LayerStackClose"));

/*
** CHECK IF THE IMAGE STATISTICS IS RIGHT.
**    IN ORDER TO GET PIXEL COUNT FROM STATISTICS, WE HAVE TO MAKE SURE
**    IT USE DIRECT BIN, AND SKIP FACTOR IS SET TO 1;
**    IF NOT RIGHT, RECALCULATE THE STATISTICS
*/
if ( (binType != EDSC_DIRECT_BINS) || (statsSkipFactorX !=1) || (statsSkipFactorY !=1) )
{
      /*
      ** PREPARE BIN FUNCTION PARAMETERS
      */
      binFunc.binFuncOption   = ERGA_FIXED_NUMBINS_BINTYPE;
      binFunc.binfunctype           = EDSC_DIRECT_BINS;

      switch (pixelType)
      {
            case EGDA_TYPE_U16:
                  binFunc.numBins         = 65536; break;
            case EGDA_TYPE_U8:
                  binFunc.numBins         = 256; break;
            default:
                  break;
      }

      /*
      ** RECALCULATE STATISTICS
      */
      layerStack = eimg_LayerStackOpen(layernames,eint_GetInit(), &lclerr,
                        EIMG_LAYER_OPTION_COMPUTE_STATS_ON_CLOSE,
                              //WILL RE-CALCULATE STATISTICS WEHN CLOSE
                        EIMG_LAYER_OPTION_DEFAULT_BIN_FUNCTION_STRUCTURE, &binFunc,
                              //SPECIFY THE BIN FUNCTION
                        EIMG_LAYER_OPTION_STATS_SKIP_FACTORS, 1, 1,
                              //SPECIFY THE SKIP FACTOR, 1 MEANS NOT SKIP.
                        EIMG_LAYER_OPTION_END);
      EERR_CHECK(lclerr, EFS0("Error eimg_LayerStackOpen"));

      /*
      ** FREE LAYERSTACK MEMORY AREA
      ** STATISTICS WILL BE RE-CALCULATED HERE!
      */
      eimg_LayerStackClose(layerStack, &lclerr);
      EERR_CHECK(lclerr, EFS0("Error eimg_LayerStackClose"));

}
else
{
      /*
      ** IF IT HAS THE RIGHT STATISTICS, THEN DO NOTHING!
      **    NO NEED TO RECALCULATE STATISTICS
      */
}
```

```
	/*
	** OPEN AGAIN!
	** THIS TIME, IT MUST HAVE THE RIGHT STATISTICS.
	** SO WE CAN DIRECTLY READ PIXEL COUNT FROM HISTOGRAM.
	*/
	layerStack = eimg_LayerStackOpen(layernames,eint_GetInit(),
			&lclerr,
			EIMG_LAYER_OPTION_END);
	EERR_CHECK(lclerr, EFS0("Error eimg_LayerStackOpen"));

	allStatStack = eimg_AllStatsStackRead(layerStack, NULL, &lclerr);

	/*
	** MAKE SURE INPUT BANDVAL IS REASONABLE.
	*/
	EERR_CHECK (bandVal > allStatStack->numLayers,
		EERR_FATAL_SET_1(__LINE__, "Band %d invalid",
		bandVal));

	/*
	*************************************************************
	** READ PIXEL COUNT DIRECTLY FROM HISTOGRAM
	*************************************************************
	*/
	numOfPixels = *((double*)EGDA_BASEDATAPTR(
			allStatStack->allStats[bandVal]->histogram,  //HISTOGRAM
			pixVal,   //ROW
			0));       //COLUMN

	#if 0
	/*
	** FOR DEBUG PURPOSE:
	** OUTPUT DEBUG INFORMATIOON INTO IMAGINE SESSION LOG
	*/
	for (i = 0; i <binFunc.numBins ; i++)
	{
		double *testPtr = NULL;
		double testVal;

		testPtr = (double*)EGDA_BASEDATAPTR(allStatStack->allStats[bandVal]->histogram,
				i,  //Row
				0); //column
		testVal = *testPtr;
		//testVal = (double)allStatStack->allStats[bandVal]->histogram->data[pixVal] ;
			// THIS DOESN'T WORK, YOU HAVE TO USE
			// EGDA_BASEDATAPTR TO VISIT EGDA_BASEDATA STRUCT.
		esmg_LogMessage(ESMG_LOG_TERSE, &lclerr, "data[%d]= %f", i, testVal);
	}
	#endif

	returnList = estr_LongToStringList(1, &numOfPixels,&lclerr);

cleanup:

	EERR_SHOW(lclerr, EERR_DEBUG);

	if (layerStack)
	{
		eimg_LayerStackClose(layerStack, &lclerr);
```

```
            EERR_DELETE( lclerr );
            layerStack = NULL;
      }
      if (layernames)
      {
            estr_StringListDelete(layernames, &lclerr);
            EERR_DELETE( lclerr );
            layernames = NULL;
      }
      if (allStatStack)
      {
            esta_AllStatsStackDelete(allStatStack, &lclerr);
            EERR_DELETE( lclerr );
            allStatStack = NULL;
      }

    /*
    ** RETURN RESULTS TO EML
    */
      return returnList;
}
```

Code Snippet (Sec6_03) : pixelcount.eml

```
/*
**********************************************************
**
** pixelcount.eml
**    THE EML SCRIPT TO CALL APPLICATION FUNCTION DLL (pixelcount.dll)
**
**********************************************************
*/
component pixelcount
{
      frame frm_Pixelcount
      {
            geometry 0,0,250,260;
            title "Count Pixel";
            resizable;

            filename    fln_Input;
            edittext    pop_Bands;
            edittext    edt_Pixelvalue;
            button            btn_Ok;
            button            btn_Close;
            variable    res;


            filename fln_Input
            {
                  geometry 20,10,210,50;
                  title above left "Input File:";
                  shortform;
```

```
        info "The input file to be used";
        select getpref("eml" "default_data_path") + "/*.img";
        filetypedef "raster";
        on filenamechoosen
        {
              /*
              ** SETUP BAND POPUPLIST
              */
              variable namelist; /* VARIABLES CAN ONLY BE DEFINED IN EVENT HANDLER */
              variable titlist;
              variable i;
              set namelist      = {};
              set titlist       = {};
              set i                   = 1;
              while ( $i <= $fln_Input.nbands() )
              {
                    set namelist = {$namelist, fmt($i,"?") };
                    set i = $i +1;
              }
              set titlist = {$titlist, $fln_Input.RasterLayerList() };/*SETUP LIST*/
              $pop_Bands.SetNameAndTitleList($namelist ,$titlist );
                          /* $pop_Bands IS A STRING, EVEN THE NAME IS NUMERIC */
        }
}

popuplist pop_Bands
{
        geometry 20,80,210,50;
        title above left "Which Band you want to count";
}

textnumber txt_Pixelvalue
{
        geometry 20, 140, 80, 50;
        title above left "PixelValue You want to count:";
        value 0;
        format "5.0";
        delta 1;
}

button btn_Ok
{
        geometry 20,210,100,40;
        title above center " Count ";
        on mousedown
        {
              /*
              ** GET BAND NUMBER (Start From 0)
              **    index start frmo 0
              **    index =0 <=> band 1
              */
              variable band;
              set band = $pop_bands.GetListIndex();

              /*
              ** Call pixelcount(), a C Application Function;
              ** This function returns the number of occurence
              ** of pixel value (i.e., $txt_Pixelvalue) from a
              ** particular band (i.e., $band) of image
              ** file (i.e., $fln_Input)
              **
```

```
                        */
                        set res = pixelcount($fln_Input,
                                             $band,
                                             $txt_Pixelvalue);
                        echo $res;
                        yesno($res);
                  }
            }

            button btn_Close
            {
                  geometry 130,210,100,40;
                  title "cancel";
                  on mousedown
                  {
                        unload;
                  }
            }

      } /* End of "frame" */

      on startup
      {
            display frm_Pixelcount;
      }

} /* End of "component" */
```

Code Explanation:

BIN Function

In order to set up the histogram, we have to set up the BINs first. Bins are used to group ranges of data values together for better manageability. Histograms and other descriptor columns for 1, 2, 4, and 8-bit data are easy to handle since they contain a maximum of 256 rows. However, to have a row in a descriptor table for every possible data value in floating point, complex, and 32-bit integer data would yield an enormous amount of information. Therefore, the bin function is provided to serve as a data reduction tool.

Types of Bin functions

The Bin function establishes the relationship between data values and rows in the descriptor table. There are four types of bin functions used in ERDAS IMAGINE image layers:

- **Direct Bin**: one bin per integer value. Used by default for 1, 2, 4, and 8-bit integer data, but may be used for other data types as well.
- **Linear Bin**: established a linear mapping between data values and bin numbers.
- **Log Bin**: established a logarithmic mapping between data values and bin numbers.
- **Explicit Bin**: explicitly defines mapping between each bin number and data range.

Bin function will determine the data values in histogram. In order to count pixel value, we need to use direct bin.

Skip Factor

The Skip factor is the value to ignore when calculating statistics, which can reduce the calculating time.

For example, here is what the Skip factor 3 means:
In X direction, one of every 3 pixels will be used to calculate statistics;
In Y direction, one of every 3 pixels will be used to calculate statisitcs;
So in both X, Y direction, one of every 9 pixels will be used to calculate statisitcs, which means 1/9 = 11.1% of pixels will be used to calculate statistics. Of course it will be quicker.

In this case, we will set all X, Y direction skip factors to 1 (using every pixel value) in order to get an accurate pixel count result.

Erga_DefaultBinStruct structure contains basic information about bin function.

Erga_DefaultBinStruct

The prototype of this structure is:

```
typedef struct {
   Erga_BinFuncOption   binFuncOption;
   long                 numBins;
   Edsc_BinFunctionType binfunctype;
} Erga_DefaultBinfStruct;
```

Edsc_BinFunctionType

The prototype of this structure is:

```
typedef enum {
   EDSC_BFT_OPAQUE = -1, /* BF details are'nt known; use edsc API only */
   EDSC_DIRECT_BINS = 0, /* Bins are partitioned one-to-one */
   EDSC_LINEAR_BINS,            /* Bins are partitioned linearly */
   EDSC_LOGARITHMIC_BINS,     /* Bins are partitioned logarithmically */
   EDSC_EXPLICIT_BINS         /* Bin partitions are given explicitly */
} Edsc_BinFunctionType;
```

Read Stats from All layers

After we set the BIN function and the skip factor we can use the **Esta** package to calculate the image statistics. Since the histogram is part of the statistics you can get the pixel count from the histogram.

Esta_AllStatsStack

The prototype of this structure is:

```
typedef struct {
         long numLayers;      /* Number of basedata objects represented
                         by these statistics */
         Esta_Covariance *cvMatrix;/* Covariance Matrix */
         Esta_AllStats  allStats;  /* Array of Esta_AllStats objects */
         Egda_Table *excludedStatsValues;     /* Values to ignore when accumu-
lating
                                statistics */
    Epxm_Double numPixels;          /* Number of pixels used to
                         produce the covariance matrix */
         Egda_Table *meanForCovariance;  /* Mean vector used to calculate
                         covariance matrix */
       long skipFactorX;            /* Skip factor in X direction */
    long skipFactorY;               /* Skip factor in Y direction */
} Esta_AllStatsStack;
```

The **Esta_AllStatsStack** structure contains a group of pointers for **Esta_AllStats** structure and a covariance matrix. It is used as a convenient way of representing all the statistical information for a layer stack with a single pointer. The number of individual **Esta_AllStats** structure is specified by **numLayers** element.

Esta_AllStats

The prototype of this structure is:

```
typedef struct {
         Epxm_Double numPixels;          /* Number of pixels used to
                         produce these statistics */
         Esta_Statistics *    statistics;     /* Scalar statistics */
         Esta_Histogram *     histogram;      /* Histogram */
    Eahg_Histogram  uvHistogram;
} Esta_AllStats;
```

The **Esta_AllStats** structure contains pointers for a statistics structure and a histogram structure.

In order to read histogram, you need **eimg_LayerStackOpen()** to find out histogram, and then Macro **EGDA_BASEDATAPTR** to get frequency (number of occurrence) of certain pixel value from histogram.

---

eimg_AllStatsStackRead()

The prototype of this API is:

```
Esta_AllStatsStack * eimg_AllStatsStackRead( Eimg_LayerStack *layerStack,
       Esta_AllStatsStack *statInfoIn,
       Eerr_ErrorReport  inerrorreport)
```

This function reads the statistics and histogram information associated with the specified eimg layer stack. NULL is returned if an error occurs while trying to read the statistics information, or if no statistics information is associated with this layer stack. Otherwise, this function returns a pointer to the destination **Esta_AllStatsStack** structure.

If **Esta_AllStatsStack** structure is returned, it may not have information for all the layers, only the ones that have associated statistics. In addition, none of the layers may have statistics info, but there may be a covariance matrix associated with the layers, in which case the returned **Esta_AllStatsStack** structure will also not be NULL. In other words, it is up to the caller to determine which parts of the **Esta_AllStatsStack** structure have non-NULL data.

eimg_AllStatsStackDelete()

The prototype of this API is:

```
Esta_AllStatsStack * eimg_AllStatsStackDelete(
      Esta_AllStatsStack *statInfoIn,
      Eerr_ErrorReport  inerrorreport)
```

This function deletes an **Esta_AllStatsStack** structure.

How do we access individual values from histogram?

Since the histogram data type is **Egda_BaseData** (**typedef Egda_BaseData Esta_Histogram**), you can use the **EGDA_BASEDATAPTR(basedata, row, column)** macro to obtain the pixel count.

You will need to properly cast this value to the correct data type and de-reference it.

For example:

```
numOfPixels = *((double*)EGDA_BASEDATAPTR(allStatStack->allStats[bandVal]->histogram,
           pixVal - (long)(allStatStack->allStats[bandVal]->statistics->minimum),
           0));
```

EGDA_BASEDATAPTR

The prototype of this MACRO is:

```
#define EGDA_BASEDATAPTR(basedata,row,column)                \
 ( ((basedata)->data) + (row)*((basedata)->pitch)+(column)*  \
  ((basedata)->numbytes) )
```

Class Notes:

Section 7: Interactive Application

Section objective:

This section outlines how to create a complete application, which communicates with the IMAGINE session manager and enables users to interact with the IMAGINE Viewer.

Packages used:

eeml

Exercise 1: Application Template

Exercise Objective:

In this exercise you will implement a standard application template and incorporate your custom EML. A solid ERDAS application, will provide a strong working relationship between EML and the C-Toolkit. There are many ways to program solutions BUT some methods are better than others. In this section, the techniques that we teach, for developing an application, provide a solid foundation for successful development with the IMAGINE C Toolkit.

One of the main reasons for creating an application is to make it independent of the EML Frameparts. This allows for the change and reuse of functions, as well as the modification of the EML, without breaking the program. We will constantly reiterate this concept while walking through the development process of creating an application.

Now, let's review some basic information about the terminology related to these techniques.

Packages used:

eeml

Application vs. Job

The first thing you need to do is to figure out what type of toolkit program that you are going to develop. IMAGINE C Toolkit supports two basic program types:

- **Application** (Interactive GUI programs**)** -- These programs use Graphical User Interfaces for interactive user input. They create an interface, present it to the user and wait infinitely for user input.
- **JOB** (Non-Interactive programs**)** -- These are programs which take user input as command line arguments and start and complete the task on their own (i.e. they will not wait for the user interaction while they are running). These programs also periodically inform the user how much of the task is currently completed.

Different programming rules are used to build APPLICATIONs or JOBs:

Programming rules for an Application

Every program which calls the function **eeml_Init()** is registered by the IMAGINE Session Manager as an APPLICATION. The communication between an Application and the Session Manager is two way (i.e. the Session Manager sends/receives commands to/from applications simultaneously). An application can call all the toolkit functions starting with **eeml_XXX** or functions defined in the eeml.h include file. An application can freely disconnect from the Session Manager with the C system call **exit()**.

Programming rules for a JOB

Every program which calls the function **esmg_JobInit()** is registered by the IMAGINE Session Manager as a JOB. The Session Manager automatically displays a progress meter for every job. A job program can call **esmg_JobProgress()** periodically to report the status of the task to the IMAGINE Session Manager so that it will be displayed in the progress meter. Jobs should also call **esmg_InterruptQuery()** function periodically. This function will return true if the user has cancelled the job through the Cancel button provided by Session Manager in the progress meter. When the task is finished, the job program must call **esmg_JobEnd()** to disconnect from the Session Manager. The communication between Jobs and the Session Manager is one way most of the time (i.e. Jobs send commands to Session Manager. For certain query commands, the Session manager will send a reply/answer back to the Job).

Jobs should not call any functions designed for Applications (i.e. functions starting with **eeml_XXX** or functions defined in **eeml.h** include file). Likewise, Applications should not call **esmg_JobInit**, **esmg_JobState**, **esmg_JobProgress**, **esmg_JobEnd**,. etc.

An Application Template

In this exercise, we will create an application template "**apptemplate.exe**", which will demonstrate the basics of an application.

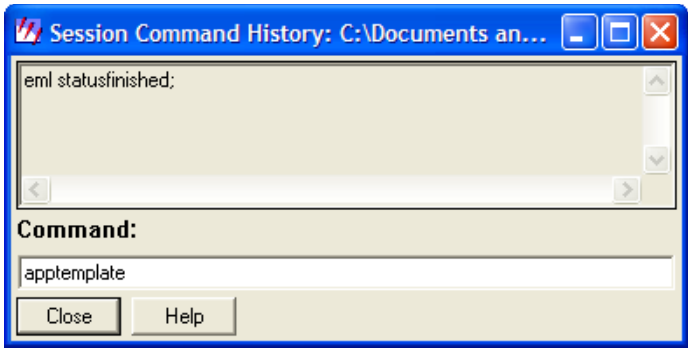
All applications will contain two components: EML script, and C source. The EML scripts will define the GUI for the application, while the C source is the actual application source code.

Below is a Pseudo template of C source code, which will help you become familiar with the framework.

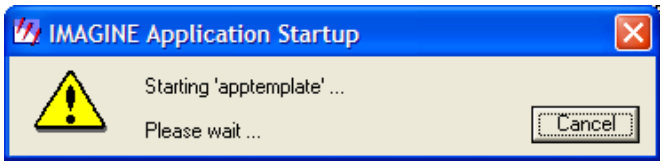
Components of Pseudo-template	Note
Standard Includes	These standard system header files include sdtio.h.
Toolkit Includes	These must reflect any packages being used in the proceeding code.
Error-Checking Macros	Error-checking is an important part of any Toolkit program.
Main structure of this application	This structure will be passed to all application functions associated with this application.
EML translation table	This translation table will map the external function name (EML function name) to an internal C function name. C function will implement the EML function, and you will not be able to call these application functions outside this application.
Main{}	This is the standard entry point of the program.
Application function (C implementation)	Similar to the application functions in Application function DLL, except application function here can only be used within this application. While application functions in application function dll can be used for all EML scripts.
Additional Functions	Functions used internally.

***Note**: The Microsoft Visual Studio project setting is similar to a JOB, you only need to add **eemllib.lib** in the Linker.*

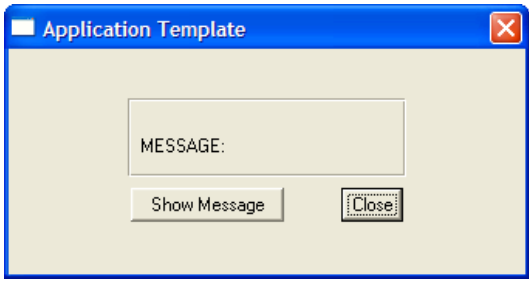
After build the example application program (Sec7_01, Sec7_02), , you can use the IMAGINE command line to run the application (shown below):



You should see a dialog when your application starts, which shows the name of your application.



The following figure shows the interface of the example application:



Code Snippet (Sec7_01): appTemplate.c

```
/*****************************************************************************
******************************************************************************
 APPLICATION : appTemplate

 PURPOSE: This will provide the template for all applications.

 NOTES:
      This template is the outline for how an Application is to be set up. This
      example will initialize, parse and launch an EML. On "Ok" the application
      will display on the EML "HELLO WORLD".

******************************************************************************
*****************************************************************************/

/*
** TOOLKIT INCLUDES
*/
#include <eint.h>
#include <eerr.h>
#include <eeml.h>
#include <eeml_dialog.h>
#include <estr.h>
#include <esmg.h>

/*
** ERROR MACROS
*/
#define EFS0( m ) EERR_FATAL_SET_0( __LINE__, m )
#define EWS0( m ) EERR_WARNING_SET_0(__LINE__, m )
#define ES0( e, m )     EERR_SHOW_0( e, EERR_DEBUG, __LINE__, m )

#define MESSAGE_COMMAND  "-message"
```

```
/*
** MAIN STRUCTURE FOR THIS APPLICATION
*/
typedef struct
{
      //FRAME PARTS
      Eui_Root               *root;
      Eml_ParseResult        *result;
      Eui_BasePart           *frm_Apptemplate;
      Eui_BasePart           *lab_DisplayMessage;
} AppContext;


/*
*****************************************************************************
** Application Function Table
**
** This table exposes internal functionality to the EML script interpreter.
** First the functions are prototyped and then inserted into the table. The
** table is used at parse time.
**
*****************************************************************************
*/
static Estr_StringList * showmessage(Eeml_Menu,Emsc_Opaque *,long ,   char **,Eerr_ErrorReport
**);
static Estr_StringList * closeapplication(Eeml_Menu,Emsc_Opaque *,long , char **,Eerr_ErrorRe-
port **);

static Eeml_TranslationTable menufunctions[] =
{
      "showmessage",               showmessage,
      "closeapplication",          closeapplication,
      NULL,NULL,
};


/*
** ADDITIONAL FUNCTIONS
*/
static void processMessageFromSessionManager(Emsc_Opaque *, int, char **,Eerr_ErrorReport **);


/*
** APPLICATION EXECUTION ENTRY POINT
*/
int main(int argc, char  **argv)
{
      EERR_INIT("main", &lclerr, lclerr);

      int                          n;
      Emsc_Opaque *                context     = NULL;
      char  **                     buf         = (char **)NULL;
      Eint_InitToolkitData   *     erdinit     = NULL;
      AppContext  *                app         = NULL;
      int                          rc               = -1;

      Etxt_Text xx;
      char * yy;

      /*
```

```
** INITIALIZE THE ERDAS TOOLKIT
*/
erdinit=eint_InitToolkit((Emsc_Opaque **)&lclerr );
EERR_CHECK( lclerr,  EFS0("eint_InitToolkit Failed"));

/*
** CREATE AND INITIALIZE THE APPLICATION CONTEXT STRUCTURE
*/
app = emsc_New( 1, AppContext );

/*
** INITILIZE THE ERDAS EML TOOLKIT PACKAGE
*/
app->root = eeml_Init( erdinit, "Application Template", argc, argv, &lclerr );
EERR_CHECK( lclerr,  EFS0("Eeml_Init Error"));


/*
** PARSE OUT THE EML WITH THE FRAME PARTS
**    This function will add application functions defined in Eeml_TranslationTable
**    to the current EML parser (only available for current application), it also
**    associate AppContext to each application functions.
*/
app->result = eeml_ParseVa(ELEX_FILE,    //Type of Parse Source
                  "apptemplate.eml",                //Name of Parsed EML script
                   app->root->rootPart,        //Rootpart
                   &lclerr,                          //Error Report
                   EEML_PARSE_OPTION_APP_FUNCTIONS, menufunctions,
                             // Defined Eeml_TranslationTable
                   EEML_PARSE_OPTION_APP_CONTEXT, (Emsc_Opaque *)app,
                             // Default Application Context
                   NULL );
EERR_CHECK( lclerr,  EFS0("eeml_ParseVa Error"));

/*
** FIND OUT OTHER EML PARTS
*/
app->frm_Apptemplate = eeml_FindPart(app->result, "frm_Apptemplate", &lclerr);
EERR_CHECK( lclerr,  EFS0("eeml_FindPart Error"));

app->lab_DisplayMessage = eeml_FindPart(app->result ,
           "frm_Apptemplate:lab_DisplayMessage", &lclerr);
EERR_CHECK( lclerr,  EFS0("eeml_FindPart Error"));

/*
** Display the frame and create the views
**    Use it when there is no "display frm_Apptemplate;" statement
**    in your eml script.
*/
//eeml_FrameDisplay(app->frm_Apptemplate , &lclerr);
//EERR_CHECK(lclerr, EFS0("eeml_FrameDisplay failed"));

/*
** PROCESS MESSAGES FROM SESSION MANAGER
*/
processMessageFromSessionManager(app, argc, argv, &lclerr);
ES0(lclerr ,  "Unable to processCommand!" );

/*
** SETS UP THE COMMAND TO LISTEN TO SESSION MANAGER.
** EXITS APPLICATION ON DONEFLAG.
```

```
	*/
	while (!app->root->doneFlag)
	{
		n = 0;
		eeml_GetNextCommand(app->root, &context, &n, &buf, &lclerr );
		ES0(lclerr ,  "Unable to get next command!" );

		/*
		** PROCESS MESSAGES FROM SESSION MANAGER
		*/
		processMessageFromSessionManager(app, n, buf, &lclerr);
		ES0(lclerr ,  "Unable to communicate with SM!" );

		/*
		** WE ARE NOT INTERESTED IN ANY OF THE COMMANDS HERE,
		** SO FREE THEM (i.e., buf)
		*/
		eeml_FreeCommand(n, buf, &lclerr);
		ES0( lclerr ,"Unable to free up command!" );
	}
	rc = 0;

cleanup:
	EERR_SHOW(lclerr, EERR_DEBUG);

	if (app->result)
		eeml_ParseResultFree(app->result);

	if (app)
		emsc_Free(app);
	return rc;
}



/*
**************************************************************************
** FUNCTION NAME: processMessageFromSessionManager
**
** Description:
**    Process commands sent to us by Session Manager. This function
**    currently knows only one command (i.e. -message).
**
**    The syntax of the command is:
**          appTemplate -message <the message you want displayed>
**
** Note: This function will be called only once at the begining. Press
** Button from EML will not call this function.
**************************************************************************
*/
static void
processMessageFromSessionManager(Emsc_Opaque *context, int argc, char **argv, Eerr_ErrorReport
**outerr)
{
	AppContext  *app        = (AppContext *) context;
	EERR_INIT("processMessageFromSessionManager", outerr, lclerr);

	/*
	** PROCESS MESSAGE.
	**    argv[0] = "apptemplate", the application name.
	**    argv[1] = "-message".
```

```
	**    argv[2] = <message content>
	*/
	if ( argc >= 3 && estr_Eqic(argv[1],MESSAGE_COMMAND) && argv[2] )
	{
		/*
		** THIS WILL UPDATE THE MESSAGE IN EML
		*/
		eeml_StringPartValueSet(app->lab_DisplayMessage , argv[2], &lclerr);
		EERR_CHECK(lclerr , EFS0( "ERROR eeml_StringPartValueSet" ));
	}
	else
	{
		esmg_LogMessage( ESMG_LOG_VERBOSE, &lclerr,
				"Ignoring unrecognized command" );
		EERR_CHECK(lclerr , EFS0( "Error with message dialog"));
	}

cleanup:

	return;
}


/*****************************************************************************
** APPLICATION FUNCTION NAME: showmessage
**
** DESCRIPTION
**    This function will return "HELLO WORLD" string back to EML
**
** RETURN VALUE
**  A (Estr_StringList *) string list which contain "HELLO WORLD"
**
*****************************************************************************/
static Estr_StringList *
showmessage(	Eeml_Menu menu,
			Emsc_Opaque *context,
			long argc,
			char **argv,
			Eerr_ErrorReport **outerr
)
{
	AppContext  *app	= (AppContext *) context;
	EERR_INIT("messageFunc", outerr, lclerr);

	eeml_StringPartValueSet(app->lab_DisplayMessage , "Hello Application!", &lclerr);
	EERR_CHECK(lclerr , EFS0( "ERROR eeml_StringPartValueSet" ));

cleanup:

	return NULL;
}


/*****************************************************************************
** APPLICATION FUNCTION NAME: closeapplication
**
** DESCRIPTION
**    This function will make the doneFlag to true, and close this application
**
** RETURN VALUE
**  NULL.
```

```
**
******************************************************************************/
static Estr_StringList *
closeapplication(
                        Eeml_Menu menu,
                        Emsc_Opaque *context,
                        long argc,
                        char **argv,
                        Eerr_ErrorReport **outerr
)
{
      AppContext  *app        = (AppContext *) context;
      EERR_INIT("closeapplication", outerr, lclerr);

      /* THIS WILL CLOSE THE APPLICATION */
      app->root->doneFlag= EMSC_TRUE;

      return NULL;
}
```

Code Snippet (Sec7_02): appTemplate.eml

```
/*
******************************************************************************
**
**    appTemplate.eml
**    This EML will be parsed by application (i.e., apptemplate.exe)
**
******************************************************************************
*/
component apptemplate
{
      frame frm_Apptemplate
      {
            title "Application Template";
            label lab_DisplayMessage;

            group grp_DisplayMessage
            {
                  geometry 75,30,180,50;

                  label lab_DisplayMessage
                  {
                        Title "MESSAGE:";
                        geometry 5,15,175,25;
                  }
            }

            button btn_ShowMessage
            {
                  below left grp_DisplayMessage;
                  title "Show Message";
```

```
                on mousedown
                {
                        /*
                        ** Call showmessage(), which is a C Application Function
                        ** and return a "Hello World" String.
                        ** display that string on Label
                        */
                        #set lab_DisplayMessage = showmessage();
                        showmessage();
                }
        }

        button btn_Close
        {
                below right grp_DisplayMessage;
                title "Close";
                on mousedown
                {
                        /*
                        ** Call closeapplication(), which is a C Application Function
                        ** and it will close the Application
                        */
                        closeapplication();
                }
        }
    }

/*
*****************************************************************************
**
**    COMPONENT PROCEDURE
**
*****************************************************************************
*/
    on startup
    {
        display frm_Apptemplate;
    }
}
```

Code Explanation:

Eeml_TranslationTable & Its Application Functions

Application functions are defined in a table known as a Translation Table of type **Eeml_TranslationTable**. This is a data structure which associates names with function pointers. This is used by the parser to extend the set of known functions. In the our example the name "**closeapplication**" is associated with the function **closeapplication** (shown below).

```
static Eeml_TranslationTable menufunctions[] =
{
      "showmessage",              showmessage,
      "closeapplication",         closeapplication,
      NULL,NULL,
};
```

Eeml_TranslationTable

The prototype of this structure is:

```
typedef struct _eeml_TranslationTable {
          Etxt_CText name;               /* External form of the name */
          Eeml_AppFunction function;/* Internal name of the function */
} Eeml_TranslationTable;
```

Each of the application functions should have the following prototype:

```
Estr_StringList *appFunc __((
      Eeml_Menu menu,          /* Unused */
      Emsc_Opaque *context,    /* Function Context */
      long argc,               /* Argument Count */
      char  argv,              /* Argument List */
      Eerr_ErrorReport  err));
```

When the application function is called each of the arguments is converted to a string and passed in via the **argv**. The number of arguments is contained in **argc**. Additionally, the context argument is a pointer to user defined data which is defined as the appdata in the **eeml_ParseVa** call.

The eeml Package

Eeml package is a collection of API functions to access the different places of the EML system (Parser, Interpreter, GUI manager, Session Manager, Batch manager, …etc). This package is built on the top of the following packages, i.e. **erasterlib.dll**, **elib.dll**, **Windows system library** (X/Xt/Motif – under unix, Win32 under Windows). This feature allows any C programmer to easily create a complete GUI based application without having any experience in the native window system.

All applications will use **eeml_Init** to initializes the EML toolkit package, and creates the **Eui_Root** as a "Root Part". The application program must call this function before calling any other function in the EML package. The returned root pointer is used in most of the subsequent EML API function calls.

eeml_Init ()

The prototype of this API is:

```
Eui_Root * eeml_Init(
    Eint_InitToolkitData *erdinit,  /* ELIB toolkit init return */
    char *appname,            /* Application name */
    int argc,                 /* argc from the main() */
    char *argv[],             /* argv from the main() */
    Eerr_ErrorReport  err          /* Error return */
)
```

The eeml_ParseVa function will parse an EML script file, it returns a **Eml_ParseResult** structure. This function allows you to get access to the EML frame parts.

eeml_ParseVa ()

The prototype of this API is:

```
Eml_ParseResult *
       eeml_ParseVa(
          Elex_SourceType type,
          Elex_ParserSource source,
          Eui_RootPart *rootPart,
          Eerr_ErrorReport  err,
          ...
       )
```

This function takes a variable argument list which speicifies the options to use when parsing the file. In our example, we use **EEML_PARSE_OPTION_APP_FUNCTIONS** and **EEML_PARSE_OPTION_APP_CONTEXT**. The **Eeml_ParseOption** structure is listed below.

```
/*
  These are used by eeml_ParseVa to add options.
*/
typedef enum {
       EEML_PARSE_OPTION_END=0,     /* End of the list */
       EEML_PARSE_OPTION_APP_FUNCTIONS,/* Translation Table */
       EEML_PARSE_OPTION_APP_CONTEXT,    /* Default application context */
       EEML_PARSE_OPTION_NO_STARTUP,     /* Do not send startup message */
       EEML_PARSE_OPTION_APP_TASK,  /* Set task for the startup */
       EEML_PARSE_OPTION_APP_SOURCE,     /* Set the source for module */
       EEML_PARSE_OPTION_EDIT_MODE, /* Let the app know about edit mode */
       EEML_PARSE_OPTION_DISPATCH_FLAG,  /* Force event updates during parse
*/
       EEML_PARSE_OPTION_QUEUE_CODE,     /* Add "code-only" EMLs to the task
queue */
       EEML_PARSE_OPTION_CHECK_HELP /* Flag to Check help. */
} Eeml_ParseOption;
```

eeml_FindPart () or eeml_PartFind()

The prototype of this API is:

```
Eeml_Part eeml_PartFind(
    Eml_ParseResult *result,  /* The parse result */
    Etxt_CText string,            /* name of the part (ex: frame:part)*/
    Eerr_ErrorReport  outerr  /* error report pointer */
)
```

This function finds a particular part in **Eml_ParseResult** and returns a pointer to that part. You must pass the name of the part in argument **string** for which you need a pointer.

The part name should include the frame name (name of the frame in the EML script) and the specific part you are interested in. In our case, "**frm_Apptemplate:lab_DisplayMessage**" is used. **frm_Apptemplate** is the frame name, **lab_DisplayMessage** is the label name.

Once the parts have all been initialized the primary or initial frame should be displayed and then the main event loop should be entered. The main event loop checks for and dispatches message within the system. The following is an example taken out of Code Snippet (Sec7_01):

:

```
while (!myData->root->doneFlag)
{
    comCount = 0;
    eeml_GetNextCommand(myData->root,&context,
         &comCount,&comBuf, &err);
    /*
      Got a command from Session Manager, process it.
    */
    processCommand(myData, comCount, comBuf);
    /*
      Free the command.
    */
    eeml_FreeCommand(comCount, comBuf, &err);
}
```

Once the primary frame is displayed then each application should enter a **while** loop which continues until the **doneFlag** in theRoot is set to TRUE. This **doneFlag** is set when the quit command is issued, or it could be set by the application code itself. The **eeml_GetNextCommand** function dispatches messages until an application command is found. When an application command is found it is returned as an array of pointers to strings in **argv** and the number of strings is returned in **argc**. The **eml_GetNextCommand** will remove the application command (directed to this application from another application or Session Manager) and return it to the application. It is up to the application to process the commands which it receives.

eeml_GetNextCommand ()

The prototype of this API is:

```
void eeml_GetNextCommand(
    Eui_Root *root,
    Emsc_Opaque  **context,
```

```
    int *argc,
    char  *argv,
    Eerr_ErrorReport  err
    )
```

This function will put your application in the event loop. This is similar to a window system main loop but there are differences. The main difference is that this function also serves the EML interpreter to process the EML events.

In addition to that, it also returns any pending commands sent to the application via Session Manager. It will yield control when there is any Session Manager command pending in the application queue.

argv is the string that contains the command arguments and **argc** the number of arguments**.** The memory is allocated for **argv** so the application need to free it after the commands are processed.

---

eeml_FreeCommand ()

The prototype of this API is:

```
void eeml_FreeCommand (
    long argc,           /* Command strings count */
    char  argv,               /* Command strings */
    Eerr_ErrorReport  err          /* Error return */
)
```

This function frees the space returned by **eeml_GetNextCommand**.

Each EML framepart has a value. You can use the **eeml** package to get the framepart value and set the framepart value. Some frameparts, such as **meternumbers**, and **textnumbers** have numeric values. Other frameparts, such as **edittexts** have string values. The functions **eeml_NumberPartValueGet** and **eeml_StringPartValueGet** are used to get the current value of any part. The functions **eeml_NumberPartValueSet** and **eeml_StringPartValueSet** set the current value of the part and update the display so that the visual appearance of the part agrees with its value.

When a part value is changed the message "**valuechanged**" is sent to the part. Every part has a dependency list. If there are any other parts whose values depend on the updated part then those parts will also be updated.

In addition, there are other functionalities in the **eeml** package.:

- Show / hide parts
- Enable / Disable parts
- Get / set part parameters (for special parts)
- Duplicate parts
- Add / remove callbacks

---

eeml_StringPartValueSet ()

The prototype of this API is:

```
void eeml_StringPartValueSet(
    Eui_BasePart *part,
    Etxt_CText string,
    Eerr_ErrorReport  outerr
```

```
)
```

This function changes the value of a part and updates the value on the screen. If **part** is NULL it returns error. If **string** is NULL, the treatment is the same as an empty string.

---

eeml_StringPartValueGet ()

The prototype of this API is:

```
char * eeml_StringPartValueGet(
    Eui_BasePart *part,
    Eerr_ErrorReport  err)
```

This function retrieves the string **part** value, and returns a pointer to string. This function allocates memory for the return string, so the caller needs to free it when it is no longer needed.

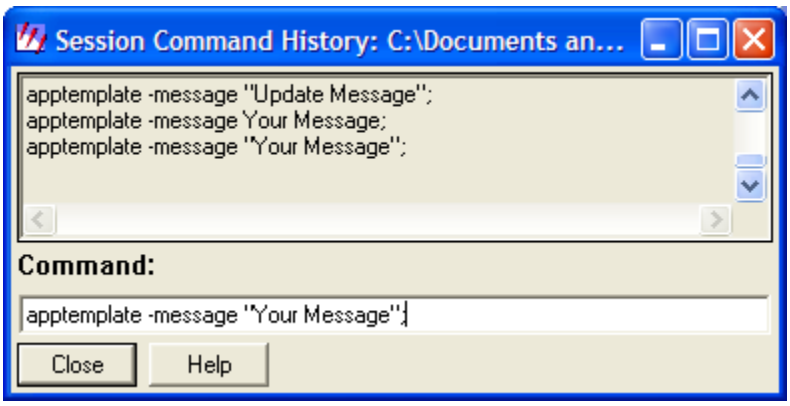
Send Message to Application

The main event loop will allow applications to listen to all the commands and messages passed throu the Session Mananger. In our case, the **processMessageFromSessionManager** function will process all message sent from session manager.

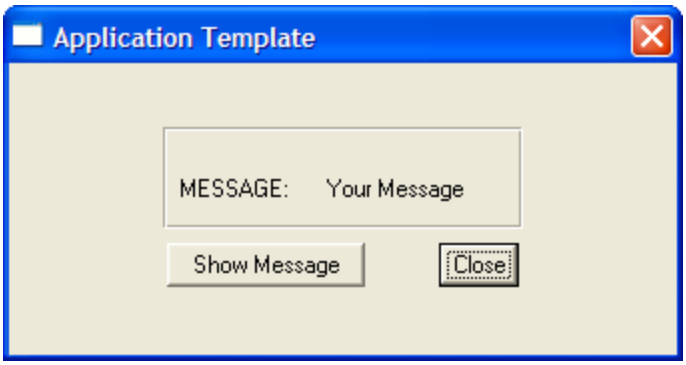
```
/*
PROCESS MESSAGES FROM SESSION MANAGER
*/
processMessageFromSessionManager(app, n, buf, &lclerr);
ES0(lclerr ,  "Unable to communicate with SM!" );
```

You can send messages to the application when the application is active. For example, you may use the IMAGINE command line to send the following command to **apptemplate.exe**.

```
Apptemplte –message “Your Message”;
```



You will notice the message is updated, which is generated from the application. In such a manner, you can talk to the application through the Session Manager.



Callback Functions (EML)

Each part may have a list of callback functions associated with it. A callback function is a function that is called by EML when a given message is delivered to a framepart. For example, the application may have a given function called when the mouse is pressed, that is when the "**mousedown**" message has been received. This association is done using the **eeml_AddCallback** function. The following is an example of adding a callback function to a button.

```
md->viewPart = eeml_FindPart( md->result,"sample_frame:viewb", errptr);

eeml_AddCallback( md->viewPart, viewPartCB,(Emsc_Opaque *)md, "mousedown",
&err);
```

The framepart "**viewb**" from frame "**sample_frame**" is found by using the **eeml_FindPart** and then the function eeml_AddCallback will associate the callback function (**viewPartCB)** with the message "mousedown". As a result whenever the user clicks on the "**OK**" button the **viewPartCB** function will be called. The callback function must have the following prototype:

```
int viewPartCB(Eui_BasePart *part, Emsc_Opaque *data)
{
    MyData * md = (MyData *)data;
      …
}
```

The **part** is a pointer to the framepart from which the function was called. The **data** is the user supplied pointer which can be used to pass user specific data into the function. The function must return either 0 or 1. EML allows multiple callbacks to the framepart for any EML predefined message. When a message is delivered to a framepart, EML will invoke each of the message handlers. By returning a value of 1 EML will terminate the loop which calls the next function.

Class Notes:

Exercise 2: Viewer Interaction

Exercise Objective:

This section will focus on developing an application that allows the analyst to place a Selector on an image displayed in an IMAGINE Viewer. They will be able to compare the location of the Selector with geographically related images, and to analyze surface features. This information is very useful in defining the characteristics of various points in a region. In developing this tool, we will be using a number of thematic and continuous images to perform the comparison.

Packages used:

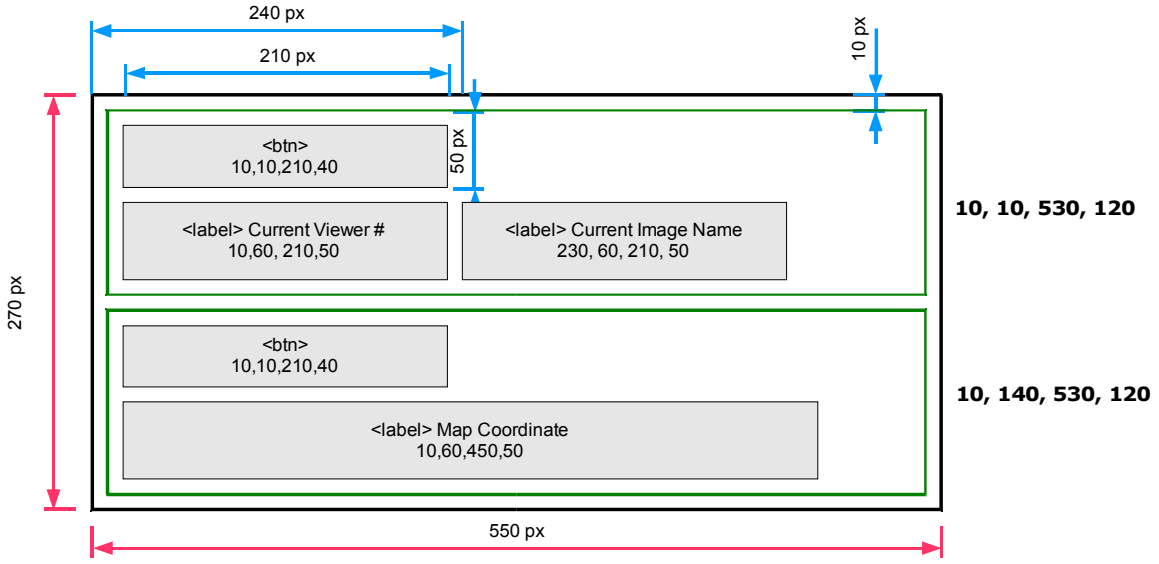
eeml

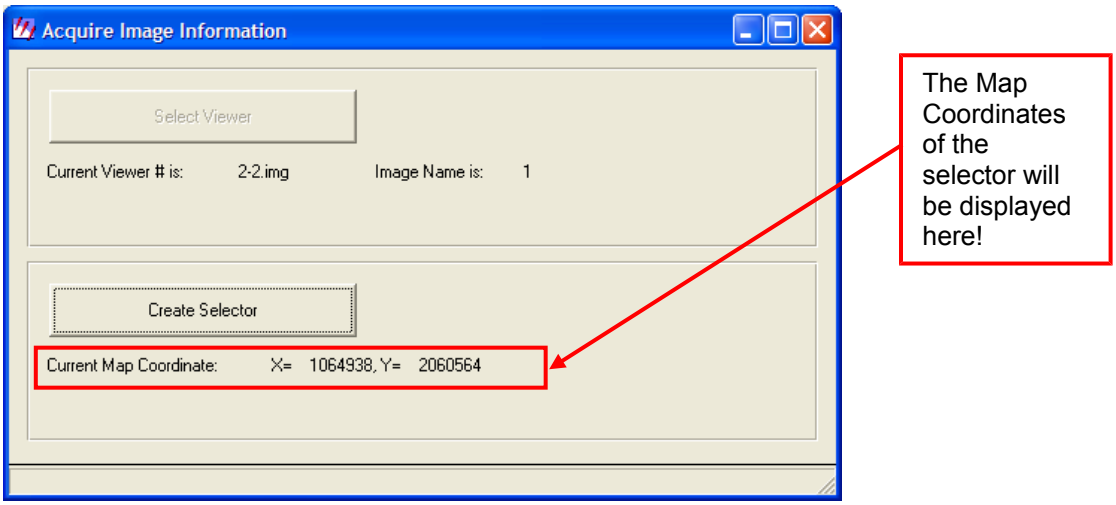
eeml_frame

eeml_dialog

Design the GUI

This exercise will create a simple GUI, which allows user to select a Viewer and create a selelctor. The **label** framepart will display the updated Map coordinates of the selector (shown below).




Acquire Image Information
Select Viewer
Current Viewer # is: 2-2.img
Image Name is: 1
Create Selector
Current Map Coordinate: X= 1064938, Y= 2060564
The Map Coordinates of the selector will be displayed here!

Code Snippet (Sec7_03): browsetool.c

```
/*****************************************************************************
******************************************************************************
 APPLICATION : browsetool

 PURPOSE: This exercise will create viewer interaction, all user to pick
      and move selector in the viewer, and update coordinate information
      from selector.

******************************************************************************
*****************************************************************************/

/*
** TOOLKIT INCLUDES
*/
#include <eint.h>
#include <eerr.h>
#include <eeml.h>
#include <eeml_frame.h>
#include <eeml_dialog.h>
#include <emsc.h>
#include <estr.h>
#include <evue.h>

/*
** ERROR MACROS
*/
#define EFS0( m ) EERR_FATAL_SET_0( __LINE__, m )
#define ES0( e, m )     EERR_SHOW_0( e, EERR_DEBUG, __LINE__, m )

/*
** MAIN STRUCTURE FOR THIS APPLICATION
*/
typedef struct
{
      /* FRAME PARTS */
      Eui_Root               *root;
      Eml_ParseResult        *result;
      Eui_BasePart           *frame;
      Eui_BasePart           *coord;

      /* EXTERNAL VIEW INTERACTION */
      Evue_Connection        *connection;
      Evue_DisplayHandle     displayHandle;
      Evue_LayerHandle       layerHandle;
      Evue_LayerInfo         *viewLayInfo;

      /* SELECTOR */
      Evue_ObjId             *pick;
      Evue_ObjId             *selector;
      double                 pointx;
      double                 pointy;

}AppContext;
```

```
/*
*****************************************************************************
** APPLICATION FUNCTION TABLE
**
** This table exposes internal functionality to the EML script interpreter.
** First the functions are prototyped and then inserted into the table. The
** table is used at parse time.
**
*****************************************************************************
*/
/*
** THIS MACRO MAKE THE IMPLEMENTATION OF APPLICATION FUNCTIONS MUCH CLEANER.
*/
#define APP_FUNC(name) \
      static Estr_StringList * name (Eeml_Menu menu, Emsc_Opaque * context, \
      long argc, char ** argv, Eerr_ErrorReport ** outerr)

APP_FUNC(getview);
APP_FUNC(dismiss);
APP_FUNC(pickpt);

Eeml_TranslationTable menufunctions[]=
{
      "getview", getview,
      "dismiss", dismiss,
      "pickpt",  pickpt,
      NULL, NULL,
};


/*
** CALLBACK FUNCTIONS DECLARATION
*/
Emsc_Boolean ViewerCloseCB (Evue_ObjId, Evue_CallbackReason, void *, int, Emsc_Opaque *,
                                    Eerr_ErrorReport **);
Emsc_Boolean SelectorMoveCB ( Evue_ObjId,Evue_CallbackReason ,void * ,int ,Emsc_Opaque *,
                                    Eerr_ErrorReport **);
void PointCreatedCB(Evue_LayerHandle, Evue_ObjId, Efga_Matrix *, int, Evue_ObjId,
                                    Eerr_ErrorReport **);
void PickCancelCB(Emsc_Pointer, Eerr_ErrorReport **);


/*
** APPLICATION EXECUTION ENTRY POINT
*/
int main(int argc, char  **argv)
{
      Eint_InitToolkitData *       erdinit = NULL;
      char*                        applicationName =  "Browse Image Info";
      int                          n;
      Emsc_Opaque *                context;
      char  **                     buf   = (char **)NULL;
      AppContext  *                app   = NULL;
      int                          rc    = -1;


      /*
      ** INITIALIZE ERROR MACRO
      */
```

```
EERR_INIT( "main", &lclerr, lclerr );

/*
** INITIALIZE THE ERDAS TOOLKIT
*/
erdinit=eint_InitToolkit((Emsc_Opaque **)&lclerr );
EERR_CHECK( lclerr,  EFS0("eint_InitToolkit Failed"));

/*
** CREATE AND INITIALIZE THE APPLICATION CONTEXT STRUCTURE
*/
app = emsc_New( 1, AppContext );

/*
** INITILIZE THE ERDAS EML TOOLKIT PACKAGE
*/
app->root = eeml_Init( erdinit, applicationName, argc, argv, &lclerr );
EERR_CHECK( lclerr,  EFS0("Eeml_Init Error"));

/*
** PARSE OUT THE EML WITH THE FRAME PARTS
*/
app->result = eeml_ParseVa(ELEX_FILE,
                        "browsetool.eml",       //GUI eml
                        app->root->rootPart,
                        &lclerr,
                        EEML_PARSE_OPTION_APP_FUNCTIONS,
                        menufunctions,               //Translation Function
                        EEML_PARSE_OPTION_APP_CONTEXT,
                        (Emsc_Opaque *)app,
                        NULL );
EERR_CHECK( lclerr,  EFS0("eeml_ParseVa Error"));

app->coord = eeml_PartFind(app->result,
            "frm_browsetool:grp_SelectorInfo:lab_MapCoordinate",
            &lclerr);
EERR_CHECK( lclerr,  EFS0("eeml_PartFind Error"));


/*
** SETS UP THE COMMAND TO LISTEN TO SESSION MANAGER.
** EXITS APPLICATION ON DONEFLAG.
*/
while (!app->root->doneFlag)
{
      /*
      ** TO PROCESS ALL APPLICATION COMMANDS, USE EEML_GETNEXTCOMMAND
      ** IN LOOP.
      */
      n = 0;
      eeml_GetNextCommand(app->root, &context,
                  &n, &buf, &lclerr );
      EERR_CHECK( lclerr,  EFS0("eeml_GetNextCommand Error"));

      /*
      ** WE ARE NOT INTERESTED IN ANY OF THE COMMANDS HERE,
      ** SO FREE THEM
      */
      eeml_FreeCommand(n, buf, &lclerr);
      EERR_CHECK( lclerr,  EFS0("eeml_FreeCommand Error"));
}
```

```
	rc = 0;

cleanup:

	EERR_SHOW(lclerr, EERR_DEBUG);
	if (app->result)
		eeml_ParseResultFree(app->result);
	if (app)
		emsc_Free(app);
	return rc;
}



/*
*****************************************************************************
** APPLICATION FUNCTION & CALLBACK FUNCTION IMPLEMENTATION
**
**  --APPLICATION FUNCTION--
**  getview
**  pickpt
**  dismiss

**  --CALLBACK FUNCTION--
**  ViewerCloseCB
**  PointCreatedCB
**  PickCancelCB
**  SelectorMoveCB
**
*****************************************************************************


/*****************************************************************************
** APPLICATION FUNCTION NAME: getview
**
** DESCRIPTION
**  This function will get the displayhandle of the viewer and the
**    layerhandle of the image. With this information it will obtain the
**    viewer number and image name and return it to the EML.
**
** EML CALLING SYNTAX:
**    getview()
**
** RETURN VALUE
**  A Stinglist, the first element is Image name;
**    the second element is the Viewer ID.
**
*****************************************************************************/
APP_FUNC( getview )
{
	AppContext		*app = (AppContext *)context;
	long			viewid   =     0;
	char			*str1 =  NULL;
	char			*str2 =  NULL;
	Estr_StringList		*listnames  =  NULL;


	EERR_INIT( "getview", outerr, lclerr );

	app->connection = evue_Open( "viewer", &lclerr );
	EERR_CHECK(lclerr , EFS0( "ERROR Evue_Open" ));
```

```
	app->displayHandle = evue_SelectViewer( app->connection, "Select Viewer", &lclerr );
	EERR_CHECK(lclerr , EFS0( "ERROR Evue_SelectViewer" ));

	if( app->displayHandle )
	{
		/*
		** CREATE CALLBACK TO VIEWER
		*/
		evue_AddCallback (app->connection, app->displayHandle,
					EVUE_OBJECT_DESTROY,
					ViewerCloseCB,
					(Emsc_Opaque*)app,
					&lclerr);
		EERR_CHECK (lclerr, EFS0 ("ERROR evue_AddCallback"));

		/*
		** GET LAYERHANDLE FROM VIEWER ( IMAGE NAME)
		*/
		app->layerHandle = evue_GetTopLayerHandle (app->connection,
					app->displayHandle, &lclerr);
		EERR_CHECK (lclerr, EFS0 ("ERROR Evue_GetTopLayerHandle"));

		/*
		** GET VIEW LAYER INFORMATION
		*/
		app->viewLayInfo = evue_GetLayerInfo(app->connection,
					app->layerHandle, &lclerr);
		EERR_CHECK (lclerr, EFS0 ("ERROR evue_GetLayerInfo"));

		/*
		** GET VIEWER DISPLAY NUMBER
		*/
		viewid = evue_GetViewNumberFromHandle (app->connection,
					app->displayHandle, &lclerr);
		EERR_CHECK (lclerr, EFS0 ("ERROR evue_GetViewNumberFromHandle"));

		/*
		** PREPARE STRING LIST TO BE RETURNED
		**    listname[0] = Image Name
		**    listname[1] = Viewer ID
		*/
		str1 = estr_Sprintf(NULL, "%s", &lclerr, app->viewLayInfo->filename);
		str2 = estr_Sprintf(NULL, "%d", &lclerr, viewid);
		EERR_CHECK (lclerr, EFS0 ("estr_Sprintf"));

		listnames = estr_StringListAppend(NULL, str1, &lclerr);
		EERR_CHECK (lclerr, EFS0 ("estr_StringListAppend"));

		estr_StringListAppend(listnames, str2, &lclerr);
		EERR_CHECK (lclerr, EFS0 ("estr_StringListAppend"));
	}

cleanup:

	return (listnames);
}


/*************************************************************************
** APPLICATION FUNCTION NAME: pickpt
```

```
**
** DESCRIPTION
**  This function will create selector in the viewer
**
** EML CALLING SYNTAX:
**    pickpt()
**
** RETURN VALUE
**  NULL
**
*****************************************************************************/
APP_FUNC( pickpt )
{
      AppContext *app = (AppContext *)context;

      EERR_INIT("pickpt", outerr, lclerr);

      if (!app->layerHandle)
            return (NULL);
      if (app->selector)
      {
            eeml_DialogWarning(NULL, "Selector Pick Already Exists", &lclerr);
            return (NULL);
      }

      app->pick = evue_PickToolCreate(
                  app->connection,  // the viewer connection
                  app->displayHandle, // display handle of viewer
                  app->layerHandle, // layer handle of viewer
                  EVUE_PICK_POINT,  // Pick type
                  PointCreatedCB,         // pick create callback
                  app,                    // client data
                  PickCancelCB,           // Pick cancel callback
                  &lclerr);
      if (lclerr)
      {
            evue_PickDestroy(app->connection, app->pick, &lclerr);
            if (lclerr) EERR_DELETE(lclerr);
      }

cleanup:

      return (NULL);
}


/*****************************************************************************
** APPLICATION FUNCTION NAME: dismiss
**
** DESCRIPTION
**  This function will close this application
**
** EML CALLING SYNTAX:
**    dismiss()
**
** RETURN VALUE
**  NULL
**
*****************************************************************************/
APP_FUNC( dismiss )
{
```

```
      AppContext *app = (AppContext *)context;

      EERR_INIT( "dismiss", outerr, lclerr );

      if (app->selector)
      {
            evue_RemoveCallback(app->connection, app->selector,
                  EVUE_SELECTOR_MOVE, SelectorMoveCB, app, &lclerr);
            EERR_CHECK(lclerr, EFS0("evue_RemoveCallback - selector"));

            evue_RemoveCallback(app->connection, app->selector,
                  EVUE_SELECTOR_RELEASE, SelectorMoveCB, app, &lclerr);
            EERR_CHECK(lclerr, EFS0("evue_RemoveCallback - selector"));

            evue_SelectorDestroy( app->connection, app->selector, &lclerr );
            EERR_CHECK(lclerr, EFS0("evue_SelectorDestroy"));

            app->selector = NULL;
      }
      if(app->connection)
      {
            evue_RemoveCallback(app->connection, app->displayHandle,
                  EVUE_OBJECT_DESTROY, ViewerCloseCB, app , &lclerr);
            EERR_CHECK (lclerr, EFS0 ("evue_RemoveCallback"));

            evue_Close(app->connection, &lclerr);
            EERR_CHECK (lclerr, EFS0 ("evue_Close"));

            app->connection = NULL;
            app->displayHandle = NULL;
      }

      app->root->doneFlag = EMSC_TRUE;

cleanup:
      return (NULL);
}



/*****************************************************************************
** CALLBACK FUNCTION NAME: ViewCloseCB
**
** DESCRIPTION
**    This is a callback that will free all allocated memory associated
**    with the viewer when the viewer is closed.
**
*****************************************************************************/
Emsc_Boolean
ViewerCloseCB (
      Evue_ObjId                  id,
      Evue_CallbackReason         reason,
      void                        *cbd,
      int                               cbdlen,
      Emsc_Opaque                 *client_data,
      Eerr_ErrorReport       **outerr
)
{
    AppContext *app = (AppContext *)client_data;

    app->displayHandle = NULL;
```

```
    app->layerHandle = NULL;

      return EMSC_FALSE;
}


/*****************************************************************************
** CALLBACK FUNCTION NAME: PointCreatedCB
**
** DESCRIPTION
**    This is a callback that create the Selector
**
*****************************************************************************/
void PointCreatedCB(
      Evue_LayerHandle            layerHandle,
      Evue_ObjId                        pick,
      Efga_Matrix                       *mat,
      int                                     nverts,
      Evue_ObjId                        client_data,
      Eerr_ErrorReport            **outerr
)
{
      AppContext *app = (AppContext *)client_data;
      double point[2];
      char *str;
      EERR_INIT("pointcreatdCB", outerr, lclerr);

      evue_PickDestroy(app->connection, app->pick, &lclerr);
      ES0(lclerr, "couldn't delete the pick");

      if (app->selector)
      {
            evue_SelectorDestroy(app->connection, app->selector, &lclerr);
            ES0(lclerr, "couldn't delete the selector");
      }

      /*
      ** UPDATE SELECTOR LOCATION
      **    This will allow cellarray to update display when the first time
      **    Selector is created, so you don't need to mvoe the selector in
      **    order to see the CellArray update
      */
      point[0] = EFGA_MATRIX(mat, 0, 0);
      point[1] = EFGA_MATRIX(mat, 1, 0);

      str = estr_Sprintf(NULL, "X= %10.8g, Y= %10.8g", &lclerr, point[0], point[1]);
      EERR_CHECK(lclerr, EFS0("Error Estr_Sprintf"));

      eeml_StringPartValueSet(app->coord, str, &lclerr);
      EERR_CHECK(lclerr, EFS0("Error eeml_StringPartValueSet"));

      app->selector = evue_SelectorCreate(app->connection,
                  app->displayHandle,
                  app->layerHandle,
                  "browsepoint",          //name string of the selector
                  EVUE_SELECTOR_GCP,      //Selector Type
                  nverts,
                  point,                        //X,Y Location
                  "Select Point",         //Label Under the ICON for the Selector
                  "gcp.icon",             //ICON used for selector
                  &lclerr);
```

```
	EERR_CHECK(lclerr, EFS0("Error evue_SelectorCreate"));

	evue_AddCallback(app->connection, app->selector, EVUE_SELECTOR_MOVE,
		SelectorMoveCB, client_data, &lclerr);
	EERR_CHECK(lclerr, EFS0("Error evue_AddCallback"));

	evue_AddCallback(app->connection, app->selector, EVUE_SELECTOR_RELEASE,
		SelectorMoveCB, client_data, &lclerr);
	EERR_CHECK(lclerr, EFS0("Error evue_AddCallback"));

cleanup:

	return;
}


/*****************************************************************************
** CALLBACK FUNCTION NAME: PickCancelCB
**
** DESCRIPTION
**    This is a callback when user cancel the pick
**         for example, click on the viewer toolbar will cancel the pick.
**         (i.e., reset window tool)
**
*****************************************************************************/
void
PickCancelCB(Emsc_Pointer data, Eerr_ErrorReport **outerr)
{
	return;
}


/*****************************************************************************
** CALLBACK FUNCTION NAME: SelectorMoveCB
**
** DESCRIPTION
**    This is a callback that will update the new position of the selector in
**    the viewer.
**
*****************************************************************************/
Emsc_Boolean SelectorMoveCB(
	Evue_ObjId			selector,
	Evue_CallbackReason		reason,
	void				*callbackData,
	int					datalen,
	Emsc_Opaque			*client_data,
	Eerr_ErrorReport	**outerr
)
{
	EERR_INIT("SelectorMoveCB", outerr, lclerr);
	double point[2];
	char *str;

	AppContext *app = (AppContext *)client_data;

	Evue_CallbackDataSelector *selectorData = (Evue_CallbackDataSelector *)callbackData;

	/*
	** UPDATE PIXEL VALUE IN CELL ARRAY
	**    Cell array will find pixel value at this location
	*/
```

```
        point[0] = EVUE_CB_VERTEX_X(selectorData, 0);
        point[1] = EVUE_CB_VERTEX_Y(selectorData, 0);

        /*
        ** UPDATE MAP CORDINATE
        */
        str = estr_Sprintf(NULL, "X= %10.8g, Y= %10.8g", &lclerr, point[0], point[1]);
        EERR_CHECK(lclerr, EFS0("Error Estr_Sprintf"));

        eeml_StringPartValueSet(app->coord, str, &lclerr);
        EERR_CHECK(lclerr, EFS0("Error eeml_StringPartValueSet"));

cleanup:
        return EMSC_TRUE;
}
```

Code Snippet (Sec7_04): browsetool.eml

```
/*
******************************************************************************
**
**    browsetool.eml
**    This EML will be parsed by application (i.e., browsetool.exe)
**
******************************************************************************
*/

component browsetool
{
      frame frm_browsetool;

      frame frm_browsetool
      {
            title "Acquire Image Information";
            geometry 0, 0, 550, 270;
            resizable;

/*
******************************************************************************
**
**    DECLARATION
**
******************************************************************************
*/
            /*
            ** FRAMEPART FORWARD DECLARATION
            */
            group grp_ViewInfo;
            button btn_ViewConnection;
            edittext edt_ViewerID;
            label lab_ViewerName;

            group grp_SelectorInfo;
            button btn_CreateSelector;
            label lab_MapCoordinate;

            variable getviewreturn;

            statusbar;

            group grp_ViewInfo
            {
                  geometry 10, 10, 530, 120;

                  /* INK TO ACTIVE VIEWER  */
                  button btn_ViewConnection #openview
                  {
                        geometry 10, 10, 210, 40;
                        title "Select Viewer";
                        on mousedown
                        {
                              set getviewreturn = getview();
                              set edt_ViewerID = fname($getviewreturn[1]);
                              set lab_ViewerName = $getviewreturn[2];
```

```
                    enable grp_SelectorInfo;
                }
        }

        /* WHERE THE VIEWER ID # WILL BE DISPLAYED  */
        edittext edt_ViewerID  #currviewtext
        {
                geometry 10, 60, 210, 50;
                title left top "Current Viewer # is:";
                readonly;
        }

        /* WHERE THE IMAGE NAME WILL BE DISPLAYED */
        label lab_ViewerName   #imagename
        {
                geometry 230, 60, 210, 50;
                title left top "Image Name is:";
        }
}


group grp_SelectorInfo
{
        geometry 10, 140, 530, 120;

        button btn_CreateSelector #getpoint
        {
                geometry 10, 10, 210, 40;
                title "Create Selector";
                on mousedown
                {
                        pickpt();
                        disable btn_ViewConnection;
                }
        }

        /*
        ** WHERE THE MAP COORDINATE WILL BE DISPLAYED
        */
        label lab_MapCoordinate #pointlocation
        {
                geometry 10, 60, 450, 50;
                title left top "Current Map Coordinate:";
        }
}

/*
** THIS DUMMY BUTTON WILL ENABLE THE EXIT ICON
*/
button btn_cancel
{
        size 0,0;
        title "Close";
        on mousedown
        {
                dismiss();
                unload;
        }
}

/*
```

```
            ** SET VARIBLES IN DISPLAY
            */
            on framedisplay
            {
                  disable grp_SelectorInfo;
            }
      }

/*
*****************************************************************************
**
**    COMPONENT PROCEDURE
**
*****************************************************************************
*/
      on startup
      {
            display frm_browsetool;
      }
}
```

Code Explanation:

The evue Package

The **evue** package allows you to write applications which communicate with a running IMAGINE Viewer, allowing you to create and destroy view windows, display layers, and add selectors which can be added and moved within the Viewer.

In order to use the **evue** package, your program must be an application, and there should be a Viewer running under the same session as your application.

The first step of Viewer interaction is to establish a **connection to a Viewer** which is currently running. **evue_Open** function opens a connection to the Viewer.

---

evue_Open ()

The prototype of this API is:

```
Evue_Connection * evue_Open (
    char *drivername,
                /* the name of the driver to connect to (e.g. "viewer") */
    Eerr_ErrorReport  err     /* the error report */
)
```

This function opens a connection to a Viewer of the given name **drivername**. Unless otherwise specified, this should always be "**viewer**". For Ribbon interface, the **drivername** should be "**ewkspace**".

The returned pointer to **Evue_Connection** structure is then used in all subsequent **evue_*** calls, which must be used as the first parameter in all calls that communicate with a Viewer.

evue_Close function is used to close a Viewer connection, it also frees the **Evue_Connection** pointer.

evue_Close ()

The prototype of this API is:

```
Evue_Connection * evue_Close (
    Evue_Connection *apc,
              /* the pointer to a connection to be closed*/
    Eerr_ErrorReport  err     /* the error report */
)
```

Individual view windows are accessed via the **Evue_DisplayHandle** type. You can get the **display handle** for an existing view window by calling **evue_SelectViewer**:

evue_SelectViewer ()

The prototype of this API is:

```
Evue_DisplayHandle evue_SelectViewer(
    Evue_Connection         *apc,
    char *message,
    Eerr_ErrorReport         err
)
```

This function displays a modal dialog instruction the user to chose a view window by clicking in it. The display handle for the view window is returned.

To create a new view window, use **evue_CreateDisplay** function, this function will creates a new view window and returns the display handle for it. To close a view window, use **evue_DestroyDisplay** function:

evue_CreateDisplay ()

The prototype of this API is:

```
Evue_DisplayHandle evue_CreateDisplay(
  Evue_Connection               *apc,
  int                            x0,
  int                            y0,
  int                            xsize,
  int                            ysize,
  Eerr_ErrorReport              err
  )
```

evue_DestroyDisplay ()

The prototype of this API is:

```
void evue_DestroyDisplay(
  Evue_Connection               *apc,
  Evue_DisplayHandle          display_id,
```

```
  Eerr_ErrorReport              err
)
```

To access individual layers displayed in a view window, the **Evue_LayerHandle** type is used. To get the handle for the top layer displayed in a particular view window, use **evue_GetTopLayerHandle**:

---

evue_GetTopLayerHandle ()

The prototype of this API is:

```
Evue_LayerHandle evue_GetTopLayerHandle (
    Evue_Connection *apc,
    Evue_DisplayHandle view_id,
    Eerr_ErrorReport  err
)
```

This function returns the layer handle for the top layer in the specified view window.

There are many functions used to display a layer in a view window, depending on the type of layer (e.g., true color, grayscale, pseuodcolor, relief, annotation, or vector):

evue_OpenAnnotationLayer
evue_OpenGrayScaleLayerWithStretch
evue_OpenPseudoColorLayer
evue_OpenReliefLayer
evue_OpenTrueColorLayerWithStretch
evue_OpenVectorLayer

Let's look at **evue_OpenTrueColorLayerWithStretch** as an example (the other functions work very similarly):

---

evue_OpenTrueColorLayerWithStretch ()

The prototype of this API is:

```
Evue_LayerHandle evue_OpenTrueColorLayerWithStretch(
  Evue_Connection               *apc,
  Evue_DisplayHandle              display_id,  /* Display Handle */
  char                          *filename,   /* The filename to display */
  int                            red,        /* Layer number for red */
  int                            green,      /* Layer number for green */
  int                            blue,       /* Layer number for blue */
  Evue_StretchType               userstretch,
  Eerr_ErrorReport              err
  )
```

This function specifies a raster layer to be displayed in RGB format. The layers to be displayed through each color gun are specified (starting from zero) by the integer pararmeters red, green, blue.

The contrast stretch method is specified by userstretch, which is defined as follows:

```
typedef enum {
      EVUE_STRETCH_DEFAULT,
      EVUE_STRETCH_USER,
      EVUE_STRETCH_NONE
```

```
} Evue_StretchType;
```

EVUE_STRETCH_DEFAULT causes the Viewer to look for a contrast table in the layer; if it finds one, it performs a contrast stretch according to the contrast table. If not, it performs a *two-standard deviation* stretch.

EVUE_STRETCH_USER causes the Viewer to display a modal dialog showing the histograms for the layers and prompting the user to set the limits for the contrast stretch.

EVUE_STRETCH_NONE does a min-max stretch on the layers.

To close a layer (i.e. delete it from a view window), use **evue_LayerClose**:

---

evue_LayerClose ()

The prototype of this API is:

```
void evue_LayerClose(
      Evue_Connection *apc,
      Evue_LayerHandle
      layer_id,
      Eerr_ErrorReport  err );
```

This closes the layer represented by **layer_id**.

Callback Functions (Viewer)

There are many instances in which you need to know when something happens in the Viewer that is not under the control of your application. For example, suppose you have displayed a layer in a view window. If the user closes that particular view window, the display handle and layer handle for that Viewer are no longer valid. However, you can add callbacks on certain Viewer events, so a specified function is called in your application when such an event occurs.

You can add a callback by calling **evue_AddCallback** function:

---

evue_AddCallback ()

The prototype of this API is:

```
void evue_AddCallback(
    Evue_Connection         *apc,
    Evue_ObjId              objectId,
    Evue_CallbackReason     reason,
    Evue_CallbackFunction   function,
    void                    *client_data,
    Eerr_ErrorReport         err
    )
```

This function adds a callback onto the given object with the specified reason.

objected is the handle for the particular **evue** object from which the callback is generated. The given object may be of type: **Evue_LayerHandle**, **Evue_DisplayHandle**, **Evue_ObjId**.

The **reason** is defined in **evue.h** (layer close, Viewer close, selector moved, ect …), which specifiy the type of event which generates the callback:

The following structure shows the location where all the reasons will be found. The list below only shows part of the reasons. For a complete list of reasons go to http://developers.lggi.com

```
typedef enum {
    EVUE_SELECTOR_GRAB, /* grabbed by mouse */
    EVUE_SELECTOR_RELEASE, /* released by mouse */
    EVUE_SELECTOR_MOVE, /* moved by mouse */
    ...
    EVUE_SELECTOR_DBLCLK, /* double clicked on by mouse
    */
    ...
    EVUE_VIEW_RESET, /* view window was cleared */
    EVUE_VIEW_ADD_LAYER, /* a new layer was added to the
    window */
    EVUE_VIEW_DELETE_LAYER, /* layer deleted */
    EVUE_VIEW_ARRANGE_LAYERS, /* order of layers was rearranged
    */
    ...
    EVUE_LAYER_TRANSFORM_CHANGED, /* transform of layer changed
    */
    EVUE_OBJECT_DESTROY, /* object was destroyed */
    ...
    EVUE_OVR_CREATED, /* Ant element created */
    EVUE_OVR_SELECTED, /* Ant element selected */
    EVUE_OVR_DESELECTED, /* Ant element deselected */
    EVUE_OVR_MOVED, /* Ant element moved */
    EVUE_OVR_MODIFIED, /* Ant element modified */
    EVUE_OVR_LISTMODIFIED, /* Ant element list modified
    */
    EVUE_OVR_DELETED, /* Ant element deleted */
    EVUE_OVR_GET_ELEMENT_BY_ID, /* Ant element requested */
    ...
} Evue_CallbackReason;
```

Many of these should be self-explanatory. Callback reasons with the "**OVR**" string are related to annotation layers. Do not use callback reasons that are not part of the complete **Evue_CallbackReason** structure .

Applications must remove these callbacks before closing the connection to the Viewer.

Evue callbacks should always be removed once they are no longer needed, and all callbacks should be removed when the application exits. If they are not removed the Viewer will continue to send callback messages to the (now non-existent) application via the Session Manager. Callbacks are removed using **evue_RemoveCallback**:

---

evue_RemoveCallback ()

The prototype of this API is:

```
void evue_RemoveCallback(
      Evue_Connection *apc,
```

```
        Evue_ObjId objectId,
        Evue_CallbackReason reason,
        Evue_CallbackFunction function,
        void *client_data,
        Eerr_ErrorReport  err );
```

Picks and Selectors

You can create and manipulate points, lines and polygons in the Viewer, as is done in the measure and profile tools, by using picks and selectors. A pick is the act of digitizing a new point, line or polygon in a Viewer via mouse interaction. A selector is a point, line or polygon which is drawn in the Viewer.

A pick is initiated by calling **evue_PickToolCreate**:

---

evue_PickToolCreate ()

The prototype of this API is:

```
Evue_ObjId evue_PickToolCreate(
    Evue_Connection           *apc,   /* the connection to use */
    Evue_DisplayHandle        view,
    Evue_LayerHandle          layer,
    Evue_PickType             type,   /* type of selector to create */
    Evue_PickCreatedFunction  funcId, /* callback function. */
    Evue_ObjId           client_data,
    Evue_PickToolCancelFunction cancelfunc,
    Eerr_ErrorReport           err
)
```

This function create a pick of the specified type. Picks are used to interactively create objects. The objects may be points, ellipses, polylines, polygons, or rectangles. **Evue_PickType** is an enumeration for the type of pick to be created:

```
typedef enum {
    EVUE_PICK_POINT, /* Single mousedown */
    EVUE_PICK_POLYGON, /* Closed polygon */
    EVUE_PICK_POLYLINE, /* Open-ended polyline */
    EVUE_PICK_RECTANGLE, /* Upper left and lower right */
    EVUE_PICK_ELLIPSE /* Upper left and lower right */
}
```

The supplied function will be called after the element has been created with the coordinates of the element. The pick will exist until the application destroys the pick.

A special cursor will appear in the view window to indicate a digitizing operation. When the user finishes digitizing, the function pointed to by **funcId** is called. **client_data** is a pointer to data you will need in the funcId function. If the user decides to cancel the pick operation, e.g. by clicking on one of the tools in the Viewer toolbar, **cancelfunc** is called. This allows you to reset a toolbar on your application. The **evue_PickCreate** returns an **Evue_ObjId** type, which is sort of a generic handle for any type of Viewer object returned from an **evue** call. You can use this handle to set callbacks, etc.

If you don't want to create multiple picks, you need to call **evue_PickDestroy** to destroy the pick. This is typically called in the function specified as the **Evue_PickCreatedFunction**, funcId in **evue_PickToolCreate()**.

evue_PickDestroy ()

The prototype of this API is:

```
void evue_PickDestroy(
    Evue_Connection         *apc,   /* the connection to use */
    Evue_ObjId      id,
    Eerr_ErrorReport         err,
)
```

A **selector** is used to represent points or regions of interest on an image. They are often used in conjunction with picks; after using a pick operation to digitize a polyline, for example, in most cases you will want to draw the same polyline as a selector. Selectors are created by calling **evue_SelectorCreate** function:

evue_SelectorCreate ()

The prototype of this API is:

```
Evue_ObjId evue_SelectorCreate(
    Evue_Connection         *apc,   /* the connection to use */
    Evue_DisplayHandle   view,
    Evue_LayerHandle     layer,
    char                    *name,  /* the name string to use */
    Evue_SelectorType       type,   /* type of selector to create */
    int                     nverts, /* number of x,y pairs in array */
    double                 *verts, /* x0,y0,x1,y1,...,xN,yN */
    char           *label,    /* label displayed under GCP selector */
    char           *iconname, /* icon used for GCP selector */
    Eerr_ErrorReport         err
)
```

The ***name*** argument is an internal name; this should be unique to your particular application.

The **Evue_SelectorType** enumeration is defined as:

```
typedef enum {
    ...
    EVUE_SELECTOR_POINT, /* a single point shown as a
    crosshair */
    EVUE_SELECTOR_GCP, /* a single point shown as an icon */
    EVUE_SELECTOR_RECTANGLE,/* a rectangular screen region not
    rotated */
    EVUE_SELECTOR_ROTBOX, /* a rotatable rectangle */
    EVUE_SELECTOR_POLYGON, /* a closed polygonal region */
    EVUE_SELECTOR_POLYLINE /* an open polyline */
    ...
} Evue_SelectorType;
```

nverts is the number of vertices used to define the selector. For points and GCP-type selectors, nverts should be 1; for rectangles and rotboxes, 4; and for polygons and polylines, any number.

verts is the array of vertices, listed as { x0, y0, x1, y1, etc. }. For the rectangle selector, the order of the points is Upper Left, Upper Right, Lower Right, Lower Left. For the rotbox, the order is Lower Left, Upper Left, Upper Right, Lower Right. This is important in the case of the rotbox so the rotation angle is computed correctly.

The ***label*** argument is a text string that will show up next to the selector in the Viewer. It is used only for GCP-type selectors.

iconname is also used only for GCP-type selectors; it is the name of the icon file used. (Note that the icon file specified must be in the same pixmap format as the default icon file for the GCP selector, **gcp.icon**.)

The handle for the selector, in the form of an **Evue_ObjId** type, is returned.

If you want to remove a selector, use **evue_SelectorDestroy** function:

---

evue_SelectorDestroy ()

The prototype of this API is:

```
void evue_SelectorDestroy(
    Evue_Connection         *apc,   /* the connection to use */
    Evue_ObjId              id,    /* the selector to destroy */
    Eerr_ErrorReport         err
)
```

You can add callbacks on selectors so that a function is called when a selector is clicked on, moved, etc. There are several callback event specifically for selectors:

```
typedef enum {
EVUE_SELECTOR_GRAB, /* grabbed by mouse */
EVUE_SELECTOR_RELEASE, /* released by mouse */
EVUE_SELECTOR_MOVE, /* moved by mouse */
...
EVUE_SELECTOR_DBLCLK, /* double clicked on by mouse */
...
} Evue_CallbackReason;
```

In our example (Sec7_03, Sec7_04), the EML script contains an additional button entitled “Create Selector” and below it, a label showing the (x, y) position for the point. Clicking on the “Create Selector” button calls the function pickpt, which in turn calls **evue_PickToolCreate**. In the Viewer, the cursor changes to a crosshair and the position of the cursor is also shown in the statusbar.

Clicking in the Viewer calls the function **PointCreatedCB**. First, **evue_PickDestroy** is called to return the Viewer cursor to normal. Next, previous selectors, if any, are removed using **evue_SelectorDestroy**. The vertex list of the pick is contained in mat, which is an **Efga_Matrix** type, which is typedef’d to **Egda_BaseData**. X values of the ith point are accessed using the macro **EFGA_MATRIX(matrix, 0, i)**, and Y values are accessed using **EFGA_MATRIX(matrix, 1, i)**. These point values are displayed in the label in the EML dialog.

A GCP selector at the point is then created by calling **evue_SelectorCreate**, and a callback is added on the selector so that the function **SelectorMoveCB** is called if the selector is moved.

Within the **SelectorMoveCB** function, the **callbackData** pointer is cast to an **Evue_CallbackDataSelector** pointer. The vertices are accessed from the **Evue_CallbackDataSelector** structure via the **EVUE_CB_VERTEX_X** and **EVUE_CB_VERTEX_Y** macros, which take as arguments the selector data pointer and the vertex number.

Class Notes:

Exercise 3: CellArray

Exercise Objective:

We now have an application which will interact with the IMAGINE Viewer, and will through Selectors, get information regarding the associated image. It would also be useful to have a table whereby we could upload geographically related cover types, and compare the pixel value or coordinate information of the image with the attribute value of a cover type.

In this section, we will incorporate a CellArray™ into the application. A CellArray is a very useful tool in being able to visualize data. It is similar to a Microsoft Excel table, consisting of columns and rows. We will create a CellArray on our current interface, so that we can load layers of the same geographical area, and compare the image pixel value against the classes in a thematic scene.

Before we start to work on the CellArray, the current layout of the interface needs to be changed to offer more functionality. In redesigning the EML, it will become apparent why we used application function instead of frame part callback whenever possible. It limits most of the redesign work to the EML.

Packages used:

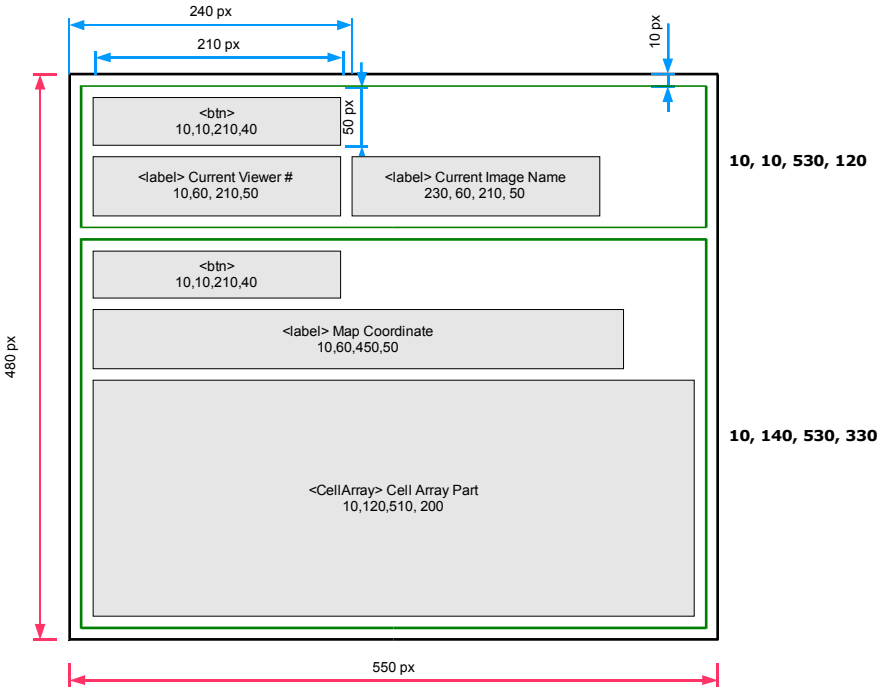
eeml

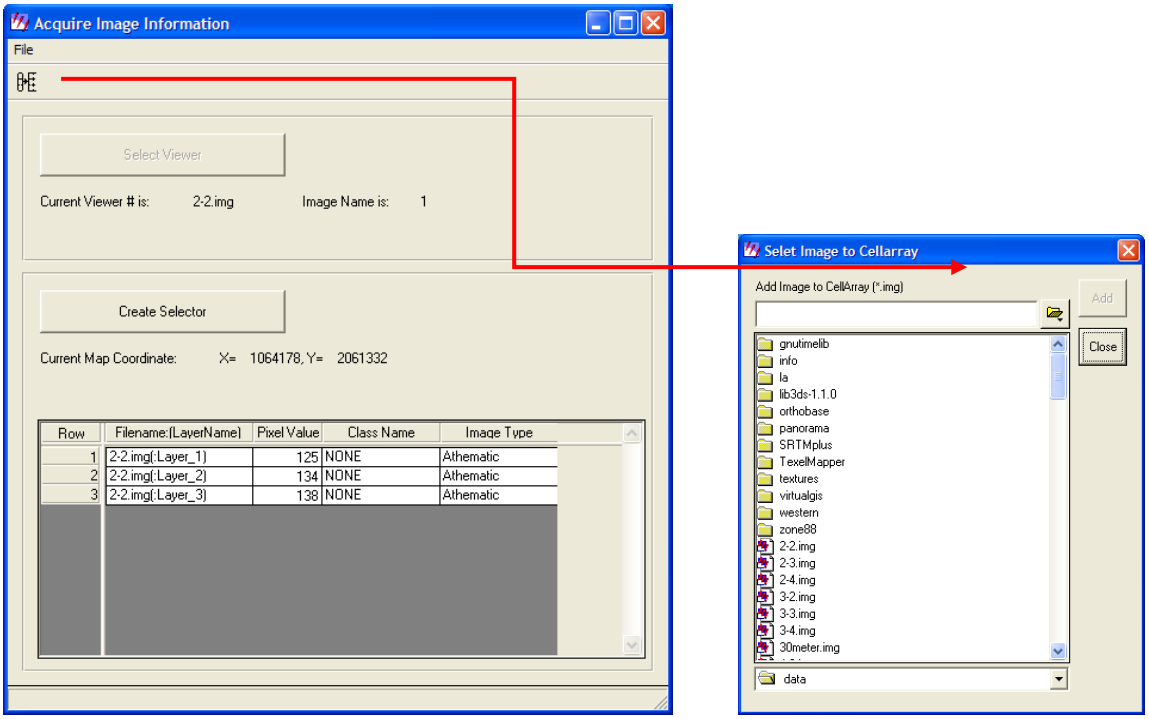
eeml_frame

eeml_dialog

Design the GUI

To Redesign the EML in order to include the layout of the CellArray. The following figures show the geometry of the GUI and what it look like:





Custom Parts: Cellarray part

Several EML capabilities are available as custom parts. These are the Histogram and the ColorWheel. There is no syntax in EML which allows these items to be declared. Instead the EML script must contain a "generic" part definition which is located and converted to one of the custom parts in the application program. (While the CellArray and Canvas parts can be treated as custom parts for backward compatibility, they have their own syntax in EML.The "generic" part should no longer be used for these parts.) Each part in EML is based on the Eui_BasePart which contains the core information such as size, position, color, etc. The Eui_BasePart also contains an array of pointers to functions which give a part its specific behavior. In the case of the parts defined in EML these function pointers are initially set by the EML Parser. For each of the custom parts, there is an Install function which is used to set up these pointers.

eeui_HistogramInstall(Eui_BasePart *part)

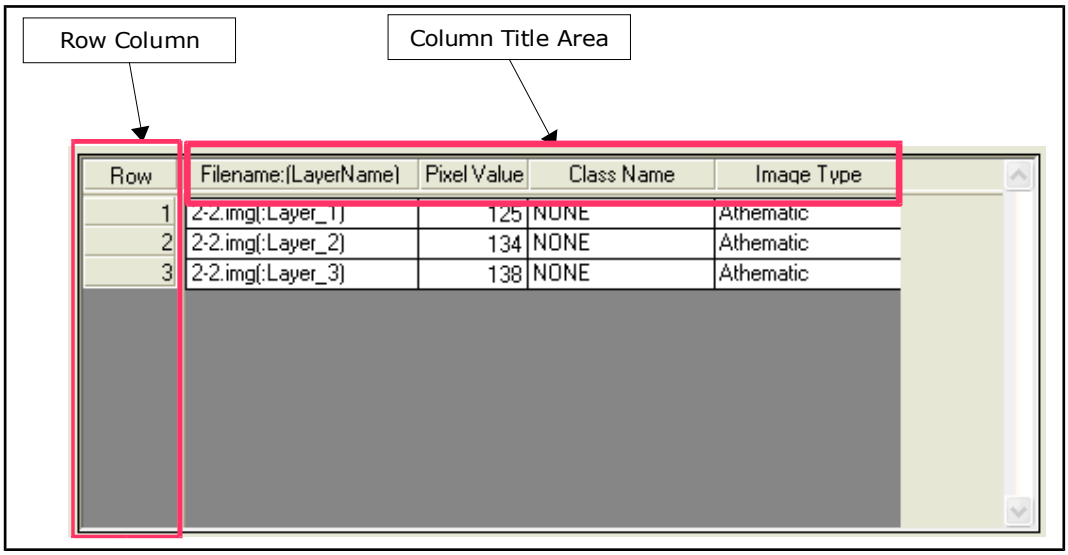
eeui_ColorWheelInstall(Eui_BasePart *part)

eeui_CellArrayInstall(Eui_BasePart *part)

The eeml_cellarray Package

The CellArray Package implements a general purpose part used for viewing and editing large (virtual) arrays of rows and columns. The CellArray provides a large set of common tools for manipulating the data such as selection, sorting, importing, exporting, formatting etc.

The CellArray manages a scrollable window which contains one or more rows. Each row is composed of one or more columns. Each column may have its own title, width, type, callback functions, etc. The layout of each row is the same.



The column on the left is the "**Row Column**" and it is used to label each row of values. **LMB** on a row and the row will be selected (highlighted in yellow). By **MMB** the selection can be extended. By **shift-LMB** the selection of a given row can be toggled. The right mouse button can be used to popup a menu of items which can be further used to control row selection.

The “**Column Title**” Area is the topmost row, it labels each column. As with the “Row Column” clicking with the left mouse button in this area will select a column (highlighting it in cyan). Clicking the middle button will extend the selection and shift-clicking the the left button will toggle the selection. The right mouse button can be used in this area to display the popup menu of commands for Copy/Paste, Import/Export etc.

The CellArray does not store any application data internally. Instead it relies on get and put functions provided by the application to provide the data as it is needed. The CellArray itself simply manages the mechanics of displaying the data. This allows access to data from any source for which the application can provide **get** and **put** functions.

There are seven different types of columns in the CellArray, these are text, number, double, boolean, exclusive, color and pixmap. Each of these different types of columns has different defaults and behaviors as described below:

TEXT COLUMNS, A text column is displayed as a text string, which is left justified in the the cell. The data for the column is transfered to and from the application as a NULL terminated text string.

NUMBER COLUMNS, A number column is displayed as a numeric text string, which is right justified in the cell. The information in the cell can be formatted using the format command in the column menu and the format can be set using the columnformat parameter described below. The data for the column is transfered to and from the application as a NULL terminated string. This has been superseded by the double column and should not be used in any new applications.

DOUBLE COLUMNS, A double column is displayed as a numeric text which is right justified in the cell. The information in the cell can be formatted using the format command in the column menu and the format can be set using the columnformat parameter described below. The data for the column is transferred to and from the application as a pointer to a double.

BOOLEAN COLUMNS, A boolean column is displayed with either a space " " or an "**x**". The "**x**" indicated that the value of the column is TRUE and the space indicates that the value of the column is FALSE. The data is transfered to and from the application as a pointer to an **Emsc_Boolean**.

EXCLUSIVE COLUMNS, An exclusive column is displayed with a "**>**" in one row and a space in all other rows. The column itself has a value which is the number of the row which has been selected. The data is transfered to and from the application as a pointer to an integer.

COLOR COLUMNS, A color column is displayed as a rectangular patch of color. The user may use the right button popup menu to select an alternate color. The is transferred to an from the application as a pointer to an array of four doubles which represent the color components as red, green, blue and opacity. The ranges of the values is 0.0 to 1.0.

PIXMAP COLUMNS, A pixmap column is displayed as a small rectangular image. The user may not interact or modify a pixmap. The value is transferred to an from the application as pointer to an **Eeml_Canvas**.

Install CellArray & Setup Parameters

The CellArray Package implements a general purpose part used for viewing and editing large (virtual) arrays of rows and columns. The CellArray provides a large set of common The CellArray can be created in a C application. The **eeui_CellArrayInstall** function is used to install the CellArray.

---

eeui_CellArrayInstall ()

The prototype of this API is:

```
void eeui_CellArrayInstall( Eui_BasePart *part)
```

This function is called to convert a generic part to a CellArray. It replaces the table of function pointers (methods) associated with a part with the table of functions for a CellArray.

To include a CellArray in an EML Frame first create a frame which contains a generic part. Once the EML has been parsed use **eeml_FindPart** to get a handle to the generic. This function is then used to convert the generic to a CellArray. This is done before the frame containing the generic is displayed. The function **eeml_SetParameters** can be used to set the parameters which govern the behavoir of the CellArray.

You may use eeml_SetParameters function to setup CellArray part parameters.

---

eeml_SetParameters ()

The prototype of this API is:

```
void eeml_SetParameters (Eui_BasePart *part, Eerr_ErrorReport  err, ...)
```

Once the CellArray has been installed the eeml_SetParameters function is used to set CellArray parameters.

This function sets the parameters passed as variable arguments into the base part structure. This function gets the different values of a part (size, width, etc.) as variable arguments and sets the **params** member of the base part structure to point to the values. These values can then be used to set the part's initial default values.

In our example, we use the following code to setup CellArray parameters: The first block of arguments is for the entire CellArray, the others are for each column.

```
eeml_SetParameters(app->cellPart, &lclerr,
    /* APPLY TO THE ENTIRE CELLARRAY */
    "showcolumn", EMSC_TRUE,
    "rowtitle", "Row",
    "selectcallback", selectCB,
    "columncount", ncols,
    "deleteenable", EMSC_FALSE,
    "fillheight", 1,
    "fillwidth", 1,
    "alwaysshowverticalscrollbar", EMSC_TRUE,
    "alwaysshowhorizontalscrollbar", EMSC_TRUE,
    /* APPLY TO COLUMN 0 */
    "column", 0,
    "columntitle", "Filename:(LayerName)",
    "columnwidth", 10,
    "columntype", "text",
    "editflag", EMSC_TRUE,
    "selectflag", EMSC_TRUE,
    "getcellvalue", getImageNameCB,
    "putcellvalue", putDummyCB,
    "cellinfo", app,
    /* APPLY TO COLUMN 1 */
    "column", 1,
    "columntitle", "Pixel Value",
    "columnwidth", 4,
    "columntype", "double",
    "editflag", EMSC_TRUE,
    "selectflag", EMSC_TRUE,
    "getcellvalue", getImageValueCB,
    "putcellvalue", putDummyCB,
    "cellinfo", app,
    ...
      /* APPLY TO COLUMN N */
      ...
      NULL);
```

Parameters for the entire CellArray

Parameters for column 0

Parameters for column 1

The following tables list the parameters which may be used with **eeml_SetParameters()** function. The first table lists the parameters which apply to the entire CellArray. The second table lists those parameters which apply only to the columns in the CellArray:

Table 1: Parameters for the entire CellArray

Parameter name	Parameter value (Type / Description)

addcolumncallback	**void (*)()**
	This is a pointer to a function which is called when the user has requested that a column be added. This is NULL by default.
	It has the form:
	`void addcolumn (`
	`  Emsc_Opaque *info,`
	`  char *name,`
	`  char *type,`
	`  int width,`
	`  int ( getfunc)(),`
	`  Emsc_Opaque  getfuncinfo,`
	`  int ( putfunc)(),`
	`  Emsc_Opaque  putfuncinfo,`
	`  void ( deletefunc)(),`
	`  Emsc_Opaque  deletefuncinfo,`
	`  Eerr_ErrorReport  err`
	`)`
	Where:
	name: the name of the new column.
	type: the type of the new column. "text", "number", "color", etc.
	width: the width of the new column.
	getfunc: receives the address of the new getfunction.
	getfuncinfo: receives the address of the new getfunction data.
	putfunc: receives the address of the new putfunction.
	putfuncinfo: receives the address of the new putfunction data.
	deletefunc: reveices the address of the new delete function.
	deletefuncinfo: receives the address of the new delete function data.

addcolumninfo	Emsc_Opaque * This is the data passed to the addcolumn() callback function.

addrowcallback	**void (*) ()**
	This function is called when a new row is added to the CellArray. The syntax is:
	`void addrow(`
	`Eui_BasePart part,`
	`int row,`
	`Emsc_Opaque *info`
	`)`
	where:
	part: the pointer to the generic part on which this CellArray is installed
	row: the number of the row being added
	info: the user provided data

addrowinfo	**Emsc_Opaque *** This is the user supplied data for the addrowcallback..
alwaysshowverticalscrollbar	**Emsc_Boolean** This flag controls whether the vertical scrollbars are always present or not. A value of **EMSC_TRUE** forces the vertical scrollbar to always be displayed. If the value value is **EMSC_FALSE** then the scrollbar is only displayed when needed. The default value is **EMSC_FALSE**.

alwaysshowhorizontalscrollbar	**Emsc_Boolean** This flag controls whether the horizontal scrollbars are always present or not. A value of **EMSC_TRUE** forces the horizontal scrollbar to always be displayed. If the value value is **EMSC_FALSE** then the scrollbar is only displayed when needed. The default value is **EMSC_FALSE**.
columncount	**long** This defines the number of columns in the CellArray. The default value is zero.
deletecallback	**void (*) ()** This is a pointer to the function to be called when the current row selection is deleted. This is set to an internal function by default.
deleteinfo	**Emsc_Opaque *** This is a pointer to the user data which is passed to the delete callback function
deleteenable	**Emsc_Boolean** This flag is set to **EMSC_TRUE** to enable the deletion of selected rows. The default value is **EMSC_FALSE**.
fillheight	**Emsc_Boolean** This flag indicates that the CellArray should fill the entire height of its area. The default for this flag is **EMSC_FALSE**.
fillwidth	**Emsc_Boolean** This flag indicates that the CellArray should fill the entire width of its area. The default for this flag is **EMSC_FALSE**.
importappendonly	**Emsc_Boolean** This flag control whether the import function only appends data and doesn't overwrite existing rows. The default value is **EMSC_FALSE**.
insertcallback	**void (*)(Emsc_Opaque *data, Boolean afterflag, int row)** This is a pointer to the function to be called when a row is inserted. There is no default function. If afterflag is 0, insert before row; if afterflag is 1, insert after row.
insertinfo	**Emsc_Opague *** This is a ponter to the user data which is passed to the insert callback function.
insertenable	**Emsc_Boolean** This flag is set to **EMSC_TRUE** to enable the insertion of selected rows. The default is **EMSC_FALSE**.
maximumrowheight	**int** This is the height (in pixels) to be used for each row. Normally the height of the rows is determined automatically by the height of the font. This allows the row height to be enlarged so that arbitrary pixmaps may be added.
mode	**char *** This is a string which indicates the mode of the CellArray. The current values are "**table**" and "**matrix**". In table mode each column is different and must have an associated set of column parameters to describe it. In matrix mode all columns are the same and are described by parameters for column 0. The default mode is "**table**".
multiputstartcallback	**void (*)(Eui_BasePart *,Emsc_Opaque *)** This is a pointer to a function which is called when the CellArray is about to begin an operation such as paste, import or formula. The default value is NULL.
multiputendcallback	**void (*)(Eui_BasePart *,Emsc_Opaque *)** This is a pointer to a function which is called after the CellArray has completed an operation such as paste, import or formula. The default value is NULL.
multiputinfo	**Emsc_Opague *** This is a pointer to data which is passed to the **multiputstartcallback**() and the **multiputendcallback**() functions. It is a pointer to user defined data.

rowalignment	**char *** This specifies the alignment for the labels in the row column. The alignment types are: "**left**", "**center**" and "**right**". The default value is **right**.
rowtitle	**char *** This is a pointer to a character string to be used as the title of the column on the left of the CellArray which is used to number the rows. The default value is "Row".
rowcolumnwidth	**long** This is the width of the row column in the CellArray.
rowcount	**long** This is the number of rows in the CellArray. The default value is **0**.
selectcallback	**void (*)(Emsc_Opaque *, Esel_SelectionTable *, Emsc_Opaque *)** This is a pointer to a function which is called when a row selection is made or changed. The first argument is a pointer to the CellArray structure and should not be used. The second argument is a pointer to the selection table which indicates which rows are selected and which are not (See the esel package). The third argument is a pointer to user supplied data. The default is NULL.
selectinfo	**Emsc_Opaque *** This is a pointer to user supplied data. It passed to the selectcallback() function. The default is NULL.
selectrange	**int[2]** This is a pointer to a two element array which contains the start and end address of a range of rows which are to be initially selected. The first row is zero. This is initially unset, i.e. there are no rows selected.
showrowcolumn	**Emsc_Boolean** This is a flag which controls the display of the leftmost column which contains the row numbers. This is **EMSC_TRUE** by default.
sortable	**Emsc_Boolean** If this flag is TRUE then the "Sort Rows.." menu item will be enabled. This is False by default.
endselectioncallback	**void (*)(Emsc_Opaque *)** This is a pointer to a function which is called when a new selection is complete. It is called with a pointer to user supplied data.
endselectioninfo	**Emsc_Opaque *** This is a pointer to user supplied data to be passed to the start **selectioncallback**() function.
startselectioncallback	**void (*)(Emsc_Opaque *)** This is a pointer to a function which is called when a new selection is started. It is called with a pointer to user supplied data.
startselectioninfo	**Emsc_Opaque *** This is a pointer to user supplied data to be passed to the start selectioncallback() function.
getrowtitles	**void (*)(Emsc_Opaque *,int, char *,int)** This is a pointer to a function to be called to get the string to be used to title the row. Rows are usually sequentially numbered. This allows the user to create any scheme for labeling the rows. The first argument is a pointer to user supplied data. The second argument is the row number which starts at zero. The third argument is the pointer to the buffer into which the function will place the string. The fourth argument is the maximum number of characters which the function may pass back to the CellArray. The default for this function in NULL.
rowinfo	**Emsc_Opaque *** This is a pointer to user supplied data which is passed to the **getrowtitles**() function. The default is NULL.
rowstartlabel	**long** This is the value to be used to label the first row (row zero). All subsequent rows are numbered sequentially from this one. The default for this is 1.

	NEXT_COLUMN. If the value is NONE (0) then when the current cell is closed no cell will be opened subsequently. If the value is NEXT_ROW (1) then when the current cell is closed the cell immediately below the current one will be opened. If the value is NEXT_COLUMN (2) then when the current cell is closed the cell in column to the right will be opened. When the end of the row is reached the first cell of the next row will be opened. The default is NEXT_ROW (1).
rowselectflag	**Emsc_Boolean** This flag is set to **EMSC_TRUE** to enable row selection. If the flag is set then rows may be selected with the cursor by clicking, shift clicking and dragging. In addition rows may be selected with the row popup menu. The default value for this is **EMSC_TRUE**.
maximumrowheight	**long** This is represents the max height of all the cell rows in screen pixels. Applications wish to use pixmaps may need to use this to set the height to the height of their pixmap. The default text height used for row height will clip the pixmap.
usecriteria	**Emsc_Boolean** If the value of this flag **is EMSC_TRUE** then the criteria selection menu is enabled. The default value for this is **EMSC_TRUE**.

The following parameters are used to set features for each column."

Table 2: Parameters for the CellArray columns

Parameter name	Parameter value (Type / Description)
alignchange	**void (*)(Emsc_Opaque *, int, char *)** This is a pointer to a function which is called if the alignment for a column is changed. The first argument is the pointer to the user data. The second argument is the column number. The first column is 0. The third argument is a pointer to the new aligment string: "left", "center", "right".
alignchangeinfo	**Emsc_Opaque *** This is a pointer to the user data for the alignchange callback.
clickcallback1	**void (*)(part, Emsc_Opaque *,row,col)** This is a pointer to the function to be called when the user clicks with the left mouse button (or the right mouse button for left-handed mice) on a cell in the column. The default action is typically provided by the CellArray itself. The **Emsc_Opaque *** is the cellinfo.
clickcallback2	**void (*)(part, Emsc_Opaque *,row,col)** This is a pointer to the function to be called when the user clicks with the middle mouse button on a cell in the column. The default action is typically provided by the CellArray itself. The **Emsc_Opaque *** is the cellinfo.
column	**long** This is the number of the column to which the following column parameters apply. The default for this is 0.
columntype	This is a pointer to a string which names the type of column. The default type is "text". The column types are: "***text***": This indicates a column whose values are strings of characters. The default alignment is "left". "***number***": This indicates a column whose values are numbers but they are given in character form. The default alignment is "right". "***double***": This indicates a column whose values are numbers and are given a doubles. The default alignment is "right" "***boolean***": This indicates a column whose values are either (true or false).

	True values are displayed as "X" and false as " ". The default alignment is "center". "***exclusive***": This indicates a column whose values are boolean and only one of which may be true at any one time. The default alignment is "center". "***color***": This indicates a column whose values are colors. "***pixmap***": This indicates a column whose values are pixmaps.
columnalignment	**char *** This specifies the alignment for the data in the column. The alignment types are: "**left**", "**center**" and "**right**". The default value depends upon the columntype.
columnchangeable	**Emsc_Boolean** This flag controls whether the size of the column is changeable. If set to **EMSC_TRUE** then the size of the column may be changed by dragging on the right hand boundary line of the column. The default value for this is **EMSC_TRUE**.
columnchooser	**Eeml_Chooser** This is a pointer to an **Eeml_Chooser** which will be invoked when the user selects the "Other..." option on the displayed chooser menu which is displayed when the user presses the left (or right) mouse button.
columnchooserclientdata	**Eeml_ChooserClientData** This is a pointer to data which is to be used by the ChooserClient created in the CellArray to communicate with the chooser.
columnchooserclientdatafree	**Eeml_ChooserDataFreeFunc** This is a pointer to the function to be called when the CellArray frees the chooser client.
columnformat	**char *** This is a pointer to a string to be used as the format for the column. See the documentation for estr_xlformat for a discussion of the format strings.
defaultcolumnformat	**char *** This is a pointer to a string to be used as the default format. This is used when the user chooses default from the column format dialog.
defaultcolumnformula	**char *** This is a pointer to a string which is used as the default formula when the formula dialog is displayed.
exclusivechangecallback	**void (*)(Emsc_Opaque *)** This is a pointer to the function which is called when the value of an exclusive column has changed. The first argument is a pointer to user defined data. The default for this is NULL.
exclusivechangeinfo	**Emsc_Opaque *** This is a pointer to user data which is to be passed to the exclusivechangecallback() function. The default for this is NULL.
columndelete	**void (*)(info, column, err)** This is a pointer to a function which is called when a column is deleted.
columndeleteinfo	**Emsc_Opaque *** This data is passed as the first argument to the columndelete() function.
columntitle	**char *** This is a pointer to the string to be used as the title for this column. This is not used if the CellArray is in matrix mode. The default for this is NULL.
columninfo	**char *** This is a pointer to a string which is used to describe the column. The message is displayed in the statusbar.
columnwidth	**long** This is the initial width for the column. It is given in characters. For example a value of 4 would mean 4 characters wide. Since the font is proportional more than 4 characters will actually be able to fit into the column. The actual number depends upon the characters.
editflag	**Emsc_Boolean** If the value of this flag is **EMSC_TRUE** then column may be edited (manu-

	ally or by paste or import). If the value is **EMSC_FALSE** then column may not be edited. The default value is **EMSC_FALSE**.
edittitleflag	**Emsc_Boolean** If the value of this flag is **EMSC_TRUE** then the title of the column may be edited. It is edited by using the "Edit Title" menu option in column popup menu. When this is done the column title becomes a text edit field in which the user may enter a new name. The default value for this is **EMSC_FALSE**.
formatchange	**void (*)(Emsc_Opaque *, int, char *)** This is a pointer to a function which is called if the format for a column changes. The first argument is the user data (formatchangeinfo), the second argument is column number, which starts at 0. The third argument is a pointer to the new format, if you wish to copy the format you must use **estr_Duplicate().** The function should return a 1.
formatchangeinfo	**Emsc_Opaque *** This is a pointer to be passed to the formatchange callback function.
criteriaflag	**Emsc_Boolean** If the value of this flag is EMSC_TRUE then this column may be used in the criteria selection dialog. If the value is EMSC_FALSE then it cannot. The default value for this is EMSC_TRUE.
getcoltitle	**int (*)(Emsc_Opaque *, int, char *,int)** This is a pointer to a function which is called to get the string to be used entitle the column. The first argument is a pointer to user supplied data. The second argument is the column number (the first column is 0). The third argument is a pointer to the buffer into which the function will place the string. The fourth argument is the maximum number of characters which the function may return. The default value for this parameter is NULL. This function should return a value of 1.
putcoltitle	**int (*)(Emsc_Opaque *, int, char *,int)** This is a pointer to a function which is called to return the new column title to the application. The first argument is the caller supplied data. The second argument is the column number (0 is the first column). The third argument is a pointer to the new title. The fourth argument is the length of the new argument. The default value for this parameter is NULL. This function should return a value of 1.
selectflag	**Emsc_Boolean** This is a flag which controls whether a column is selectable. If the flag is **EMSC_TRUE** then the column may be selected. If it is **EMSC_FALSE** then the column may not be selected. The default for this is **EMSC_TRUE**.
getcellvalue	**int (*)(Emsc_Opaque *, int, int, char *, int)** This is a pointer to the function used by the CellArray to get value for each cell of the column. It is called each time the CellArray needs to display the column data for a given cell. The default for this is NULL. If this parameter is not defined then the cellarray will contain no data. The use of the arguments depends upond the column type. This function should return a value of 1. The column types are: "***text***": The first argument is a pointer to user defined data. The second is the row. The third argument is the column. The fourth argument is a pointer to a character buffer into which the application places the text. The fifth is the maximum number of characters which may be placed in the buffer. "***number***": The first argument is a pointer to user defined data. The second is the row. The third argument is the column. The fourth argument is a pointer to a character buffer into which the application places the number encoded as a text string. The fifth is the maximum number of characters which may be placed in the buffer. "***double***": The first argument is a pointer to user defined data. The second is the row. The third argument is the column. The fourth argument is a pointer to a double into which the application places the return value.

	"***boolean***": The first argument is a pointer to user defined data. The second is the row. The third argument is the column. The fourth argument is a pointer to an Emsc_Boolean into which the application places the the boolean value (unencoded). The fourth argument is unused. "***color***": The first argument is a pointer to user defined data. The second is the row. The third argument is the column. The fourth argument is a pointer to Emsc_Color. This type specifies the color of patch. "***pixmap***": The first argument is a pointer to user defined data. The second is the row. The third argument is the column. The fourth argument is a pointer to Eeml_Canvas.
opacityflag	**Emsc_Boolean** This flag indicates that this is a colorcolumn which supports opacity. It is only valid for a color column. The default value for this is EMSC_FALSE.
putcellvalue	**int (*)(Emsc_Opaque *, int, int, char *, int)** This is a pointer to the function used by the CellArray to save the value once and edit operation has been performed. The interpretation of the arguments is the same as those for getcellvalue() with direction of the data transfer reversed. The default value for this parameter is NULL. This function should return a value of 1.
cellinfo	**Emsc_Opaque *** This is a pointer to user defined data which is passed to the **getcellvalue**() and the **putcellvalue**() callback functions. The default value is NULL
linewidth	**long** This is the width of the line on the right hand side of the column. The width is given in pixels. The default value for this is 1.
widthchange	**void (*)(Emsc_Opaque *, int, double)** This is a pointer to a function which is called when the width of a column is changed. The first argument is the user data. The second argument is the number of the column (0 is the first column). The third argument is the new column width given as a number of characters which may be fractional.
widthchangeinfo	**Emsc_Opaque *** This is a pointer to the data to be passed to the widthchange function

Add Data into CellArray & Update CellArray

After we install the CellArray and setup its parameters, we can add data into Cellarray and upate its value when necessary

eeui_CAAppendRows ()

The prototype of this API is:

```
void eeui_CAAppendRows(
    Eui_BasePart *part,        /* The CellArray Part */
    int state,           /* The Selection state for the new rows*/
    Emsc_Boolean scrollflag,   /* TRUE to Display the new rows */
    int count,                 /* The number of rows to append */
    Eerr_ErrorReport  err           /* The Status */
)
```

This function appends a user defined number of new rows onto the end of the CellArray. Each of the new rows will have the selection state as indicated by the state flag. If the scrollflag is set to **EMSC_TRUE** then the CellArray will be scrolled so that the new rows will be visiable.

After loading data into CellArray, you need to call **eeui_CAUpdateAll** function to update the display. In our example, we call **eeui_CAUpdateAll** function within **SelectorMoveCB** callback function.

---

eeui_CAUpdateAll ()

The prototype of this API is:

```
void eeui_CAUpdateAll(
    Eui_BasePart *part,       /* The cellarray part */
    Eerr_ErrorReport  err          /* The Status */
)
```

This function causes the entire visible set of rows and column for the given CellArray to be updated. This function also calls the application's get value function to insure that the most recent data is displayed.

Map Coordinate to File Coordinate Conversion

In order to read pixel value, we can use **eimg_LayerRead()** function. This function requires the file coordinates, so we need to convert the map coordinates to file coordinates since the Selector only returns Map coordinates. We can use the **exfr_XFormCreateFromMapInfo** function to create a transformation, and then use that transformation to convert the map coordinate to file coordinates (pixel based).

---

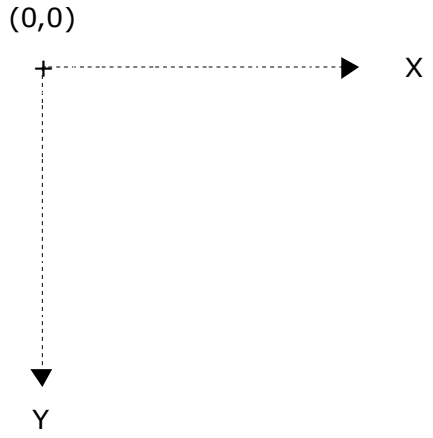
exfr_XFormCreateFromMapInfo ()

The prototype of this API is:

```
Exfr_XForm *
exfr_XFormCreateFromMapInfo( Eprj_MapInfo *mapInfo, Emsc_Boolean invert,
                         Eerr_ErrorReport  inerr )
```

This function create an **Exfr_XForm** from an **Eprj_MapInfo** structure. **Eprj_MapInfo** is a structure that defines a map view for a raster output device. The projection and units describe the type of map coordinate system that is being viewed. These parameters will be used to convert the object being viewed (annotation, raster, vector, aoi, etc.) into the proper map system before viewing. The upper left center and lower right center define the relationship of the viewed map coordinate system to the pixel map coordinate system as well as the bounds of the map coordinate system that is to be viewed. The upper left center of the pixel map system is (0,0) with the positive axis increasing to the right and the positive y axis increasing below.

Pixel Map System Coordinate Axes



The map system to be viewed can have coordinate axes that have a different relationship than those of the viewed pixel map system. By examining the relationship between the upper left center and lower right center of the **Eprj_MapInfo** structure (i.e., the map viewing parameters) we can determine how the map is to be oriented with respect to the pixel map system. Note that **Eprj_MapInfo** always assumes the map coordinate system will be viewed without distortion from an orthogonal X and Y axis, one of which is vertically oriented and the other horzontaly oriented in the Viewer.

The cell size defines the resolution of the map to be viewed (on the raster device). Cell sizes are always positive numbers. By using the cell size and the upper left center coordinate and by bearing in mind the relationship of the Viewer map system coordinate axes to the viewed pixel map system, a transformation from pixel coordinates to map coordinates can be appropriately constructed.

If the invert flag is **EMSC_TRUE**, the map to pixel transform is returned.

The transform returned must be freed by a call to **exfr_XFormFree()**.

Code Snippet (Sec7_05): browsetool.h

```
/*****************************************************************************
******************************************************************************
 FILENAME: browsecell.h

 PURPOSE: This file will includes all system and Toolkit includes, declare
      the functions and structures, which will be used in browsetool.c and
      browsecell.c.

******************************************************************************
*****************************************************************************/

/*
** SYSTME INCLUDES
*/

#include <string.h>

/*
** TOOLKIT INCLUDES
*/
#include <eint.h>
#include <eerr.h>
#include <eeml.h>
#include <eeml_frame.h>
#include <eeml_dialog.h>
#include <eeml_cellarray.h>
#include <emsc.h>
#include <estr.h>
#include <evue.h>
#include <efnp.h> //FILE NODE LIST PARSE
#include <eprj.h>
#include <esta.h>
#include <eimg.h>

/*
** ERROR MACROS
*/
#define EFS1( msg, arg ) EERR_FATAL_SET_1( __LINE__, msg, arg )
#define EFS0( msg ) EERR_FATAL_SET_0( __LINE__, msg )
#define ES0( e, msg ) EERR_SHOW_0( e, EERR_DEBUG, __LINE__, msg )

/*
** MAIN STRUCTURE FOR THIS APPLICATION
*/
typedef struct
{
      /* FRAME PARTS */
      Eui_Root               *root;
      Eml_ParseResult        *result;
      Eui_BasePart           *frame;
      Eui_BasePart           *coord;
      Eui_BasePart           *cellPart;
      Estr_StringList        *listNames;
      Etxt_Char              imgLayerName[ESTR_MAX_PATH_LEN];
```

```
        /* EXTERNAL VIEW INTERACTION */
        Evue_Connection         *connection;
        Evue_DisplayHandle      displayHandle;
        Evue_LayerHandle        layerHandle;
        Evue_LayerInfo          *viewLayInfo;

        /* SELECTOR */
        Evue_ObjId              *pick;
        Evue_ObjId              *selector;
        double                  pointx;
        double                  pointy;
        int                     digitalnumber;

}AppContext;


/*
** THIS MACRO MAKE THE IMPLEMENTATION OF APPLICATION FUNCTIONS MUCH CLEANER.
*/
#define APP_FUNC(name) \
        static Estr_StringList * name (Eeml_Menu menu, Emsc_Opaque * context, \
        long argc, char ** argv, Eerr_ErrorReport ** outerr)

APP_FUNC(getview);
APP_FUNC(dismiss);
APP_FUNC(pickpt);
APP_FUNC(addimage);


/*
** CALLBACK FUNCTIONS DECLARATION (VIEWER & SELECTOR)
*/
Emsc_Boolean ViewerCloseCB (Evue_ObjId, Evue_CallbackReason,
                                        void *, int, Emsc_Opaque *, Eerr_ErrorReport **);
Emsc_Boolean SelectorMoveCB (Evue_ObjId,Evue_CallbackReason,
                                        void * ,int ,Emsc_Opaque *, Eerr_ErrorReport **);
void PointCreatedCB (Evue_LayerHandle, Evue_ObjId, Efga_Matrix *,
                                        int, Evue_ObjId, Eerr_ErrorReport **);
void PickCancelCB (Emsc_Pointer, Eerr_ErrorReport **);


/*
** CALLBACK FUNCTIONS DECLARATION (CELLARRAY)
*/
extern void setupCellarray(AppContext *, Eerr_ErrorReport **);
static void selectCB(Emsc_Opaque*, Esel_SelectionTable *, Emsc_Opaque *);
static int getImageNameCB(char *, int, int, char *, int);
static int getImageValueCB(char *, int, int, double *);
static int getClassNameCB(char *, int, int, char *, int);
static int getImageTypeCB(char *, int, int, char *, int);
static int putDummyCB(char *, int, int, char *, int);
static Egda_F64 getRasterValue( AppContext *app, Eerr_ErrorReport **err);
```

Code Snippet (Sec7_06): browsetool.c

```
/*****************************************************************
******************************************************************
 APPLICATION : browsetool

 PURPOSE: This exercise will create viewer interaction, all user to pick
      and move selector in the viewer, and update coordinate information
      from selector.

******************************************************************
******************************************************************/

/*
** INCLUDE APPLICATION HEADER
*/
#include "browsetool.h"

/*
*******************************************************************************
** APPLICATION FUNCTION TABLE
**
** This table exposes internal functionality to the EML script interpreter.
** First the functions are prototyped and then inserted into the table. The
** table is used at parse time.
**
*******************************************************************************
*/

Eeml_TranslationTable menufunctions[]=
{
      "getview", getview,
      "dismiss", dismiss,
      "pickpt",  pickpt,
      "addimage", addimage,
      NULL, NULL,
};

/*
** APPLICATION EXECUTION ENTRY POINT
*/
int main(int argc, char  **argv)
{
      Eint_InitToolkitData*        erdinit = NULL;
      char  *                      applicationName =  "Browse Image Info";
      int                          n;
      Emsc_Opaque *                context;
      char  **                     buf = (char **)NULL;
      AppContext  *                app = NULL;
      int                          rc = -1;


      /*
      ** INITIALIZE ERROR MACRO
      */
      EERR_INIT( "main", &lclerr, lclerr );
```

```
/*
** INITIALIZE THE ERDAS TOOLKIT
*/
erdinit=eint_InitToolkit((Emsc_Opaque **)&lclerr );
EERR_CHECK( lclerr,  EFS0("eint_InitToolkit Failed"));

/*
** CREATE AND INITIALIZE THE APPLICATION CONTEXT STRUCTURE
*/
app = emsc_New( 1, AppContext );

/*
** INITILIZE THE ERDAS EML TOOLKIT PACKAGE
*/
app->root = eeml_Init( erdinit, applicationName, argc, argv, &lclerr );
EERR_CHECK( lclerr,  EFS0("Eeml_Init Error"));

/*
** PARSE OUT THE EML WITH THE FRAME PARTS
*/
app->result = eeml_ParseVa(ELEX_FILE,
                        "browsetool.eml",       //GUI eml
                        app->root->rootPart,
                        &lclerr,
                        EEML_PARSE_OPTION_APP_FUNCTIONS,
                        menufunctions,               //Translation Function
                        EEML_PARSE_OPTION_APP_CONTEXT,
                        (Emsc_Opaque *)app,
                        NULL );
EERR_CHECK( lclerr,  EFS0("eeml_ParseVa Error"));

/* FIND OUT MAP COORDINATE */
app->coord = eeml_PartFind(app->result,
            "frm_browsetool:grp_SelectorInfo:lab_MapCoordinate",
            &lclerr);
EERR_CHECK( lclerr,  EFS0("eeml_PartFind Error"));

/* SETUP CELLARRAY */
app->cellPart = eeml_FindPart(app->result,
            "frm_browsetool:grp_SelectorInfo:cel_Browseinfo", &lclerr);
EERR_CHECK( lclerr,  EFS0("eeml_FindPart Error"));

setupCellarray(app, &lclerr);
EERR_CHECK(lclerr, EFS0("Error setting up cellarray"));


/*
** SETS UP THE COMMAND TO LISTEN TO SESSION MANAGER.
** EXITS APPLICATION ON DONEFLAG.
*/
while (!app->root->doneFlag)
{
      /*
      ** To Process All application commands, use eeml_GetNextCommand
      ** in loop.
      */
      n = 0;
      eeml_GetNextCommand(app->root, &context,
                  &n, &buf, &lclerr );
      EERR_CHECK( lclerr,  EFS0("eeml_GetNextCommand Error"));
```

```
            /*
            ** We are not interested in any of the commands here,
            ** so free them
            */
            eeml_FreeCommand(n, buf, &lclerr);
            EERR_CHECK( lclerr,  EFS0("eeml_FreeCommand Error"));
      }
      rc = 0;

cleanup:

      EERR_SHOW(lclerr, EERR_DEBUG);

      if (app) emsc_Free(app);

      return rc;
}



/*
*****************************************************************************
** APPLICATION FUNCTION & CALLBACK FUNCTION IMPLEMENTATION
**
**  --APPLICATION FUNCTION--
**  getview
**  pickpt
**  dismiss
**    addimage

**  --CALLBACK FUNCTION--
**  ViewerCloseCB
**  PointCreatedCB
**  PickCancelCB
**  SelectorMoveCB
**
*****************************************************************************


/*****************************************************************************
** APPLICATION FUNCTION NAME: getview
**
** DESCRIPTION
**  This function will get the displayhandle of the viewer and the
**    layerhandle of the image. With this information it will obtain the
**    viewer number and image name and return it to the EML.
**
** EML CALLING SYNTAX:
**    getview()
**
** RETURN VALUE
**  A Stinglist, the first element is Image name;
**    the second element is the Viewer ID.
**
*****************************************************************************/
APP_FUNC( getview )
{
      AppContext              *app = (AppContext *)context;
      long                    viewid   =     0;
      char                    *str1 =  NULL;
      char                    *str2 =  NULL;
```

```
    Estr_StringList        *listnames  =  NULL;


    EERR_INIT( "getview", outerr, lclerr );

    app->connection = evue_Open( "viewer", &lclerr );
    EERR_CHECK(lclerr , EFS0( "ERROR Evue_Open" ));

    app->displayHandle = evue_SelectViewer( app->connection, "Select Viewer", &lclerr );
    EERR_CHECK(lclerr , EFS0( "ERROR Evue_SelectViewer" ));

    if( app->displayHandle )
    {
        /*
        ** CREATE CALLBACK TO VIEWER
        */
        evue_AddCallback (app->connection, app->displayHandle,
                          EVUE_OBJECT_DESTROY,
                          ViewerCloseCB,
                          (Emsc_Opaque*)app,
                          &lclerr);
        EERR_CHECK (lclerr, EFS0 ("ERROR evue_AddCallback"));

        /*
        ** GET LAYERHANDLE FROM VIEWER ( IMAGE NAME)
        */
        app->layerHandle = evue_GetTopLayerHandle (app->connection,
                          app->displayHandle, &lclerr);
        EERR_CHECK (lclerr, EFS0 ("ERROR Evue_GetTopLayerHandle"));

        /*
        ** GET VIEW LAYER INFORMATION
        */
        app->viewLayInfo = evue_GetLayerInfo(app->connection,
                          app->layerHandle, &lclerr);
        EERR_CHECK (lclerr, EFS0 ("ERROR evue_GetLayerInfo"));

        /*
        ** GET VIEWER DISPLAY NUMBER
        */
        viewid = evue_GetViewNumberFromHandle (app->connection,
                          app->displayHandle, &lclerr);
        EERR_CHECK (lclerr, EFS0 ("ERROR evue_GetViewNumberFromHandle"));

        /*
        ** PREPARE STRING LIST TO BE RETURNED
        **    listname[0] = Image Name
        **    listname[1] = Viewer ID
        */
        str1 = estr_Sprintf(NULL, "%s", &lclerr, app->viewLayInfo->filename);
        str2 = estr_Sprintf(NULL, "%d", &lclerr, viewid);
        EERR_CHECK (lclerr, EFS0 ("estr_Sprintf"));

        listnames = estr_StringListAppend(NULL, str1, &lclerr);
        EERR_CHECK (lclerr, EFS0 ("estr_StringListAppend"));

        estr_StringListAppend(listnames, str2, &lclerr);
        EERR_CHECK (lclerr, EFS0 ("estr_StringListAppend"));
    }

cleanup:
```

```
      return (listnames);
}


/*****************************************************************************
** APPLICATION FUNCTION NAME: pickpt
**
** DESCRIPTION
**  This function will create selector in the viewer
**
** EML CALLING SYNTAX:
**    pickpt()
**
** RETURN VALUE
**  NULL
**
*****************************************************************************/
APP_FUNC( pickpt )
{
      AppContext *app = (AppContext *)context;

      EERR_INIT("pickpt", outerr, lclerr);

      if (!app->layerHandle)
            return (NULL);

      /* ONLY ALLOW ONE SELECTOR */
      if (app->selector)
      {
            eeml_DialogWarning(NULL, "Selector Pick Already Exists", &lclerr);
            return (NULL);
      }

      /* CREATE A PICK */
      app->pick = evue_PickToolCreate(
                  app->connection,        // THE VIEWER CONNECTION
                  app->displayHandle,     // DISPLAY HANDLE OF VIEWER
                  app->layerHandle,       // LAYER HANDLE OF VIEWER
                  EVUE_PICK_POINT,        // PICK TYPE
                  PointCreatedCB,         // PICK CREATE CALLBACK
                  app,                    // CLIENT DATA
                  PickCancelCB,           // PICK CANCEL CALLBACK
                  &lclerr);
      if (lclerr)
      {
            evue_PickDestroy(app->connection, app->pick, &lclerr);
            if (lclerr) EERR_DELETE(lclerr);
      }

cleanup:
      return (NULL);
}


/*****************************************************************************
** APPLICATION FUNCTION NAME: dismiss
**
** DESCRIPTION
**  This function will close this application
**
```

```
** EML CALLING SYNTAX:
**    dismiss()
**
** RETURN VALUE
**  NULL
**
*****************************************************************************/
APP_FUNC( dismiss )
{
      AppContext *app = (AppContext *)context;

      EERR_INIT( "dismiss", outerr, lclerr );

      if (app->selector)
      {
            /*
            ** WE NEED TO COMMENT OUT THE CODE BELOW.
            **    This will cause cellarray to be updated whenever
            **    selector is moved. This will slow down the performance.
            **    So only update when Selector release.
            */
            /*
            evue_RemoveCallback(app->connection, app->selector,
                  EVUE_SELECTOR_MOVE, SelectorMoveCB, app, &lclerr);
            EERR_CHECK(lclerr, EFS0("evue_RemoveCallback - selector"));
            */


            evue_RemoveCallback(app->connection, app->selector,
                  EVUE_SELECTOR_RELEASE, SelectorMoveCB, app, &lclerr);
            EERR_CHECK(lclerr, EFS0("evue_RemoveCallback - selector"));

            evue_SelectorDestroy( app->connection, app->selector, &lclerr );
            EERR_CHECK(lclerr, EFS0("evue_SelectorDestroy"));

            app->selector = NULL;
      }
      if(app->connection)
      {
            evue_RemoveCallback(app->connection, app->displayHandle,
                  EVUE_OBJECT_DESTROY, ViewerCloseCB, app , &lclerr);
            EERR_CHECK (lclerr, EFS0 ("evue_RemoveCallback"));

            evue_Close(app->connection, &lclerr);
            EERR_CHECK (lclerr, EFS0 ("evue_Close"));

            app->connection = NULL;
            app->displayHandle = NULL;
      }

      app->root->doneFlag = EMSC_TRUE;

cleanup:
      return (NULL);
}



/*****************************************************************************
** APPLICATION FUNCTION NAME: addimage
**
```

```
** DESCRIPTION
**  This function will Add selected Image (all layers) to CellArray
**
** EML CALLING SYNTAX:
**    addimage($imagename)
**
**
** RETURN VALUE
**  NULL
**
*****************************************************************************/
APP_FUNC (addimage)
{
      AppContext *app = (AppContext *)context;
      EERR_INIT("addImageFunc", outerr, lclerr);

      Estr_StringList *layernames  = NULL;
      int i;

      EERR_CHECK(argc < 1, EFS0("Error, no input received"));

      /* CALLER WILL PASS THE IMAGINE NAME AS ARGUMENT argv[0] */
      layernames = eimg_LayerGetNames(argv[0], eint_GetInit(), &lclerr);
      EERR_CHECK(lclerr, EFS0("Error eimg_LayerGetNames"));

      /* MAKE SURE IMAGE IS VALID */
      EERR_CHECK(layernames->count < 1, EFS0("Error: No layers in image"));

      /* ADD ALL LAYERS NAME INTO STRING LIST */
      for ( i = 0; i < layernames->count; i++)
      {
            if (!app->listNames)
            {
                  app->listNames = estr_StringListAppend(NULL, layernames->strings[i],
                                                         &lclerr);
                  EERR_CHECK(lclerr, EFS0("Error: estr_StringListAppend"));
            }
            else
            {
                  estr_StringListAppend(app->listNames, layernames->strings[i], &lclerr);
                  EERR_CHECK(lclerr, EFS0("Error: estr_StringListAppend"));
            }
      }

      /*
      ** CREATE NEW SPACE IN CELLARRAY
      **    The callback function for CellArray will take care filling the
      **    content for the new rows in CellArray
      */
      /* UPDATE THE NUMBER OF ROWS FOR CELLARRAY */
      eeml_SetValues(app->cellPart, &lclerr, "rowcount", app->listNames->count, NULL);
      EERR_CHECK(lclerr, EFS0("Error: eeml_SetValues"));

      /* CREATE NEW SPACE FOR CELLARRAY */
      eeui_CAAppendRows(app->cellPart, 0, EMSC_TRUE, app->listNames->count, &lclerr);
      EERR_CHECK(lclerr, EFS0("Error: eeui_CAAppendRows"));


cleanup:
      if (layernames)
      {
```

```
            estr_StringListDelete(layernames, &lclerr);
            EERR_DELETE( lclerr );
            layernames = NULL;
      }

      return (NULL);
}


/*****************************************************************************
** CALLBACK FUNCTION NAME: ViewCloseCB
**
** DESCRIPTION
**    This is a callback that will free all allocated memory associated
**    with the viewer when the viewer is closed.
**
*****************************************************************************/
Emsc_Boolean
ViewerCloseCB (
      Evue_ObjId                  id,
      Evue_CallbackReason         reason,
      void  *                     cbd,
      int                         cbdlen,
      Emsc_Opaque *               client_data,
      Eerr_ErrorReport  **        outerr
)
{
      AppContext *app = (AppContext *)client_data;

      app->displayHandle = NULL;
      app->layerHandle = NULL;

      return EMSC_FALSE;
}


/*****************************************************************************
** CALLBACK FUNCTION NAME: PointCreatedCB
**
** DESCRIPTION
**    This is a callback that create the Selector
**
*****************************************************************************/
void PointCreatedCB(
      Evue_LayerHandle            layerHandle,
      Evue_ObjId                  pick,
      Efga_Matrix *               mat,
      int                         nverts,
      Evue_ObjId                  client_data,
      Eerr_ErrorReport  **        outerr
)
{
      AppContext *app = (AppContext *)client_data;
      double point[2];
      char *str   = NULL;
      EERR_INIT("pointcreatdCB", outerr, lclerr);

      evue_PickDestroy(app->connection, app->pick, &lclerr);
      EERR_CHECK(lclerr, EFS0("Error evue_PickDestroy"));

      if (app->selector)
```

```
	{
		evue_SelectorDestroy(app->connection, app->selector, &lclerr);
		EERR_CHECK(lclerr, EFS0("Error evue_SelectorDestroy"));
	}

	point[0] = EFGA_MATRIX(mat, 0, 0);
	point[1] = EFGA_MATRIX(mat, 1, 0);

	/*
	** UPDATE SELECTOR LOCATION
	**    This will allow cellarray to update display when the first time
	**    Selector is created, so you don't need to mvoe the selector in
	**    order to see the CellArray update
	*/
	app->pointx = point[0];
	app->pointy = point[1];


	str = estr_Sprintf(NULL, "X= %10.8g, Y= %10.8g", &lclerr, point[0], point[1]);
	EERR_CHECK(lclerr, EFS0("Error Estr_Sprintf"));

	eeml_StringPartValueSet(app->coord, str, &lclerr);
	EERR_CHECK(lclerr, EFS0("Error eeml_StringPartValueSet"));

	app->selector = evue_SelectorCreate(app->connection,
			app->displayHandle,
			app->layerHandle,
			"browsepoint",		//name string of the selector
			EVUE_SELECTOR_GCP,	//Selector Type
			nverts,
			point,			//X,Y Location
			"Select Point",		//Label Under the ICON for the Selector
			"gcp.icon",		//ICON used for selector
			&lclerr);
	EERR_CHECK(lclerr, EFS0("Error evue_SelectorCreate"));

	/*
	** We have to comment out the code below.
	**    This will cause cellarray to be updated whenever
	**    selector is moved. This will slow down the performance.
	**    So only update when Selector release.
	*/
	/*
	evue_AddCallback(app->connection, app->selector, EVUE_SELECTOR_MOVE,
		SelectorMoveCB, client_data, &lclerr);
	EERR_CHECK(lclerr, EFS0("Error evue_AddCallback"));
	*/

	evue_AddCallback(app->connection, app->selector, EVUE_SELECTOR_RELEASE,
		SelectorMoveCB, client_data, &lclerr);
	EERR_CHECK(lclerr, EFS0("Error evue_AddCallback"));

cleanup:

	return;
}


/*****************************************************************************
** CALLBACK FUNCTION NAME: PickCancelCB
**
```

```
** DESCRIPTION
**    This is a callback when user cancel the pick
**          for example, click on the viewer toolbar will cancel the pick.
**          (i.e., reset window tool)
**
*****************************************************************************/
void
PickCancelCB(Emsc_Pointer data, Eerr_ErrorReport **outerr)
{
      return;
}


/*****************************************************************************
** CALLBACK FUNCTION NAME: SelectorMoveCB
**
** DESCRIPTION
**    This is a callback that will update the new position of the selector in
**    the viewer.
**
*****************************************************************************/
Emsc_Boolean SelectorMoveCB(
      Evue_ObjId                    selector,
      Evue_CallbackReason           reason,
      void  *                       callbackData,
      int                           datalen,
      Emsc_Opaque *                 client_data,
      Eerr_ErrorReport**            outerr
)
{
      EERR_INIT("SelectorMoveCB", outerr, lclerr);
      double point[2];
      char *str = NULL;

      AppContext *app = (AppContext *)client_data;

      Evue_CallbackDataSelector *selectorData = (Evue_CallbackDataSelector *)callbackData;

      point[0] = EVUE_CB_VERTEX_X(selectorData, 0);
      point[1] = EVUE_CB_VERTEX_Y(selectorData, 0);

      /*
      ** UPDATE PIXEL VALUE IN CELL ARRAY
      **    Cell array will find pixel value at this location
      */
      app->pointx = point[0];
      app->pointy = point[1];

      eeui_CAUpdateAll(app->cellPart, &lclerr);
      EERR_CHECK(lclerr, EFS0("Error eeui_CAUpdateAll"));

      /*
      ** UPDATE MAP CORDINATE
      */
      str = estr_Sprintf(NULL, "X= %10.8g, Y= %10.8g", &lclerr, point[0], point[1]);
      EERR_CHECK(lclerr, EFS0("Error Estr_Sprintf"));

      eeml_StringPartValueSet(app->coord, str, &lclerr);
      EERR_CHECK(lclerr, EFS0("Error eeml_StringPartValueSet"));

cleanup:
```

```
        return EMSC_TRUE;
}
```

Code Snippet (Sec7_07): browsecell.c

```
/*****************************************************************************
******************************************************************************
 browsecell.c

 PURPOSE: This part will setup the CellArray, and fill in the content to
      CellArray with Callback functions.

******************************************************************************
******************************************************************************/

/*
** INCLUDE APPLICATION HEADER
*/
#include "browsetool.h"

/*****************************************************************************
** FUNCTION NAME: setupCellarray:
**
** DESCRIPTION:
**  Install a cellarray custom part on generic part. Also setup
**  parameters for the cellarray.
******************************************************************************
*/
extern void setupCellarray(
      AppContext *app,
      Eerr_ErrorReport **outerr
 )
{
      EERR_INIT("setupCellarray", outerr, lclerr);
      int ncols = 4;

      eeui_CellArrayInstall(app->cellPart);

      eeml_SetParameters(app->cellPart, &lclerr,

            /* APPLY TO THE ENTIRE CELLARRAY */
            "showcolumn", EMSC_TRUE,
            "rowtitle", "Row",
            "selectcallback", selectCB,
            "columncount", ncols,
            "deleteenable", EMSC_FALSE,
            "fillheight", 1,
            "fillwidth", 1,
            "alwaysshowverticalscrollbar", EMSC_TRUE,
            "alwaysshowhorizontalscrollbar", EMSC_TRUE,

            /* APPLY TO COLUMN 0 */
            "column", 0,
            "columntitle", "Filename:(LayerName)",
            "columnwidth", 10,
            "columntype", "text",
            "editflag", EMSC_TRUE,
            "selectflag", EMSC_TRUE,
            "getcellvalue", getImageNameCB,
```

```
            "putcellvalue", putDummyCB,
            "cellinfo", app,

            /* APPLY TO COLUMN 1 */
            "column", 1,
            "columntitle", "Pixel Value",
            "columnwidth", 4,
            "columntype", "double",
            "editflag", EMSC_TRUE,
            "selectflag", EMSC_TRUE,
            "getcellvalue", getImageValueCB,
            "putcellvalue", putDummyCB,
            "cellinfo", app,

            /* APPLY TO COLUMN 2 */
            "column", 2,
            "columntitle", "Class Name",
            "columnwidth", 8,
            "columntype", "text",
            "rowalignment", "center",
            "editflag", EMSC_TRUE,
            "selectflag", EMSC_TRUE,
            "getcellvalue", getClassNameCB,
            "putcellvalue", putDummyCB,
            "cellinfo", app,

            /* APPLY TO COLUMN 3 */
            "column", 3,
            "columntitle", "Image Type",
            "columnwidth", 8,
            "columntype", "text",
            "rowalignment", "center",
            "editflag", EMSC_TRUE,
            "selectflag", EMSC_TRUE,
            "getcellvalue", getImageTypeCB,
            "putcellvalue", putDummyCB,
            "cellinfo", app,

            NULL);
      EERR_CHECK(lclerr, EFS0("eeml_SetParameters"));

      /* UPDATE CELLARRAY */
      eeui_CAUpdateAll(app->cellPart, &lclerr);
      EERR_CHECK(lclerr, EFS0("Error eeui_CAUpdateAll"));

cleanup:
      return;
}


/*****************************************************************************
** CALLBACK FUNCTION FOR ENTIRE CELLARRAY:
**
** PARAMETER / PARAMETER VALUE:
**    selectcallback /  selectCB
**
** DESCRIPTION:
**    This function will be called when a row selection is made or changed.
**
*****************************************************************************/
static void selectCB(
```

```
      Emsc_Opaque *private,        // A pointer to the CELLARRAY structure (NOT USED)
      Esel_SelectionTable *sel,    /* A pointer to the selection table which indicate
                                                  which rows are selected and which are not
                                                  (see esel package)*/
      Emsc_Opaque *data            // A pointer to user supplied data
)
{
      AppContext *app = (AppContext *)data;
      EERR_INIT("selectCB", &lclerr, lclerr);

      return;
}


/*****************************************************************************
** CALLBACK FUNCTION FOR SINGLE CELLARRAY COLUMN
**
** COLUMN TYPE: text
**
** PARAMETER / PARAMETER VALUE:
**    getcellvalue /    getImageNameCB
**
** DESCRIPTION:
**    get value for each cell of the column. It is called each time the CELLARRAY needs
**    to display the column data for a given cell.
**
*****************************************************************************/
static int getImageNameCB(
      char *data,       // Pointer to user data
      int row,          // Row number
      int column,       // Column number
      char *text,       // A pointer to a char buffer into which the application places the
text.
      int size          // the max number of char which may be placed in the buffer
      )
{
      AppContext *app = (AppContext *)data;
      EERR_INIT("getImageNameCB", &lclerr, lclerr);
      Etxt_Char layer[256];
      int maxlen = 256;

      if (app->listNames)
      {
            strcpy(app->imgLayerName, app->listNames->strings[row]);
            if (!app->imgLayerName) return 0;
            estr_GetLayerPart(app->imgLayerName, layer, maxlen);
      }

      strncpy(text, layer, size);
      return 1;
}



/*****************************************************************************
** CALLBACK FUNCTION FOR SINGLE CELLARRAY COLUMN
**
** COLUMN TYPE: double
**
** PARAMETER / PARAMETER VALUE:
**    getcellvalue /    getImageValueCB
```

```
**
** DESCRIPTION:
**    get value for each cell of the column. It is called each time the CELLARRAY needs
**    to display the column data for a given cell.
**
*****************************************************************************/
static int getImageValueCB(
      char *data,       // Pointer to user data
      int row,          // Row number
      int column,       // Column number
      double *number    // A pointer to a double into which application places the return value
      )
{
      AppContext *app = (AppContext *)data;
      EERR_INIT("getImageValueCB", &lclerr, lclerr);
      Egda_F64 dnVal;
      * number = 0;

      if (app->listNames)
      {
            strcpy(app->imgLayerName, app->listNames->strings[row]);
            if (!app->imgLayerName) return 0;
            dnVal = getRasterValue(app, &lclerr);
            *number = dnVal;
      }

      return 1;
}



/*****************************************************************************
** CALLBACK FUNCTION FOR SINGLE CELLARRAY COLUMN
**
** COLUMN TYPE: text
**
** PARAMETER / PARAMETER VALUE:
**    getcellvalue /    getClassNameCB
**
** DESCRIPTION:
**    get value for each cell of the column. It is called each time the CELLARRAY needs
**    to display the column data for a given cell.
**    In this case, it will read class name for each pixel (if the image is thematic
**    image)
**
*****************************************************************************/
static int getClassNameCB(
      char *data,       // Pointer to user data
      int row,          // Row number
      int column,       // Column number
      char *text,       // A pointer to a char buffer into which the application places the
text.
      int size          // the max number of char which may be placed in the buffer
)
{
      AppContext *           app              = (AppContext *)data;
      Eimg_Layer *           layer       = NULL;
      Esta_ClassNames * classtable  = NULL;
      long nbins = 0;
      double dnVal = 0;
      EERR_INIT("getClassNameCB", &lclerr, lclerr);
```

```
	if (app->listNames)
	{
		strcpy (app->imgLayerName,		// destination string
				app->listNames->strings[row]); // source string

		if (!app->imgLayerName) return 0;

		layer = eimg_LayerOpen(app->imgLayerName, eint_GetInit(), &lclerr,
			EIMG_LAYER_OPTION_READONLY, EIMG_LAYER_OPTION_END);
		EERR_CHECK(lclerr, EFS0("Error Opening Image!"));

		if (layer->layerType == 0)
		{
			dnVal = getRasterValue(app, &lclerr);

			classtable = eimg_ClassNamesRead(layer,
				classtable, 0L, ESTA_THROUGH_END_OF_TABLE, &lclerr);
			EERR_CHECK(lclerr, EFS0("Error Getting Class Names!"));

			strncpy(text,			// destination string
				classtable->strings[(int)dnVal],	// source string
				size);				// number of charactres to copy
		}
		else
		{
			strncpy(text, "NONE ", size);
		}
	}

cleanup:
	if (layer)
	{
		eimg_LayerClose(layer, &lclerr);
		EERR_DELETE(lclerr);
		layer = NULL;
	}
	if (classtable)
	{
		esta_ClassNamesDelete(classtable, &lclerr);
		EERR_DELETE(lclerr);
		classtable= NULL;
	}

	return 1;
}


/*****************************************************************************
** CALLBACK FUNCTION FOR SINGLE CELLARRAY COLUMN
**
** COLUMN TYPE: text
**
** PARAMETER / PARAMETER VALUE:
**    getcellvalue /    getImageTypeCB
**
** DESCRIPTION:
**    get value for each cell of the column. It is called each time the CELLARRAY needs
**    to display the column data for a given cell.
**
*****************************************************************************/
```

```
static int getImageTypeCB(
      char *data,       // Pointer to user data
      int row,          // Row number
      int column,       // Column number
      char *text,       // A pointer to a char buffer into which the application places the
text.
      int size          // the max number of char which may be placed in the buffer
      )
{
      AppContext *app = (AppContext *)data;
      EERR_INIT("getImageTypeCB", &lclerr, lclerr);
      Eimg_Layer  *layer = NULL;

      if (app->listNames)
      {
            estr_StringCopy(app->imgLayerName, app->listNames->strings[row]);

            if (!app->imgLayerName) return 0;

            layer = eimg_LayerOpen(app->imgLayerName, eint_GetInit(), &lclerr,
                  EIMG_LAYER_OPTION_READONLY, EIMG_LAYER_OPTION_END);
            EERR_CHECK(lclerr, EFS0("Error Opening Image!"));

            switch( layer->layerType )
            {
                  case 0 :
                        etxt_Text_strncpy(text, "Thematic", size);
                        break;
                  case 1 :
                        etxt_Text_strncpy(text, "Athematic", size);
                        break;
            }
      }

cleanup:
      eimg_LayerClose(layer, &lclerr);
      EERR_DELETE(lclerr);

      return 1;
}



/*****************************************************************************
** CALLBACK FUNCTION FOR SINGLE CELLARRAY COLUMN
**
** COLUMN TYPE: All Types
**
** PARAMETER / PARAMETER VALUE:
**    putcellvalue /    putDummyCB
**
** DESCRIPTION:
**    This function will be used by the CELLARRAY to save the value once and edit operation
**    has been performed. This interpretation of the arguments is the same as those
**    for getcellvalue() with direction of the data transfer reversed.
**    In this case, this is only a dummy function.
**
*****************************************************************************/
static int putDummyCB (
      char *data,
      int row,
```

```
	int column,
	char *text,
	int size
)
{
	AppContext *app = (AppContext *)data;
	EERR_INIT("putDummyCB", &lclerr, lclerr);

	return 1;
}


/*****************************************************************************
** INTERNAL FUNCTION (NOT CALLBACK FUNCTION)

** DESCRIPTION:
**    This function will find the pixel digital value based on the pixel location
**
*****************************************************************************/
static Egda_F64 getRasterValue(
	AppContext *app,
	Eerr_ErrorReport **outerr
)
{
	Eimg_Layer  *		rlayer = NULL;
	Estr_StringList  *	layernames = NULL;
	Eprj_MapInfo    *	mapinfo = NULL;
	Eimg_PixelRect  *	pixrect = NULL;
	Efga_Matrix *		transmatrix = NULL;
	Exfr_XForm *		xForm = NULL;
	double ulx, uly, w, h;
	double x;
	double y;
	int fx, fy;
	Egda_F64 rval;

	EERR_INIT("getRasterValue", outerr, lclerr);

	/* GET CURRENT MAP COORDINATE FOR SELECTOR */
	x = app->pointx;
	y = app->pointy;


	/* OPEN LAYER, GET MAP INFO */
	rlayer = eimg_LayerOpen(app->imgLayerName, eint_GetInit(), &lclerr,
		EIMG_LAYER_OPTION_READONLY, EIMG_LAYER_OPTION_END);
	EERR_CHECK(lclerr, EFS0("Error: eimg_LayerOpen!"));

	mapinfo = eimg_LayerMapInfoGet(rlayer, &lclerr);
	EERR_CHECK(lclerr, EFS0("Error: eimg_LayerMapInfoGet!"));

	pixrect = eimg_PixelRectCreate(1,1, EGDA_TYPE_F64, &lclerr);
	EERR_CHECK(lclerr, EFS0("Error: eimg_PixelRectCreate!"));

	/*
	** MAP COORDINATE -> PIXEL COORDINATE
	**    Before read pixel value, you will need to convert the map coordinates
	**    to file coordinates. (Since Selector only return Map coordinates, while
	**    the pixel value is based on file coordinates. )
	*/
	transmatrix = efga_MatrixCreate(2,2,&lclerr);
```

```
    EERR_CHECK(lclerr, EFS0("Error: efga_MatrixCreate!"));

    /*
    ** SMALL TRICK: MAKE CONVERSION MORE PRECISE
    **  Need to do a slight shift in order to accurately get the return
    **    in the viewer.
    **      _______    _______
    **     |*      |   |       |  + 1/2 pixel in x direction
    **     |       |-> |   *   |=
    **     |_______|   |_______|  + 1/2 pixel in y direction
    **
    */
    EFGA_MATRIX(transmatrix,0L,0L) = x + (mapinfo->pixelSize->width/2);
    EFGA_MATRIX(transmatrix,1L,1L) = y - (mapinfo->pixelSize->height/2);

    /* CREATE A MAP->PIXEL TRANSFORMATION */
    xForm = exfr_XFormCreateFromMapInfo( mapinfo,
                EMSC_TRUE,  // EMSC_TRUE = map to pixel, EMSC_FALSE = pixel to map
                &lclerr );
    EERR_CHECK(lclerr, EFS0("Error creating xForm from MapInfo" ) );

    exfr_Transform( xForm, transmatrix, transmatrix, &lclerr );
    EERR_CHECK(lclerr, EFS0("Error transforming map coords to pixel coords" ) );

    fx = EFGA_MATRIX(transmatrix,0L,0L);
    fy = EFGA_MATRIX(transmatrix,1L,1L);


    /* READ PIXEL VALUE BASED ON FILE COORDINATES */
    eimg_LayerRead(rlayer, fx, fy, 1, 1, pixrect, &lclerr);
    EERR_CHECK(lclerr, EFS0("Error: eimg_LayerRead!"));

    rval = *((Egda_F64 *)EIMG_DATAPTR(pixrect, 0, 0));

    /* RETURN DIGITAL NUMBER TO APP */
    app->digitalnumber=rval;


cleanup:

    if (rlayer)
    {     eimg_LayerClose(rlayer, &lclerr);
          EERR_DELETE( lclerr );
          rlayer = NULL;
    }
    if (layernames)
    {     estr_StringListDelete(layernames, &lclerr);
          EERR_DELETE( lclerr );
          layernames = NULL;
    }
    if (mapinfo)
    {     eprj_MapInfoFree(&mapinfo);
          mapinfo = NULL;
    }
    if (xForm)
    {     exfr_XFormFree(&xForm, &lclerr);
          EERR_DELETE( lclerr );
          xForm = NULL;
    }
    if (pixrect)
    {     eimg_PixelRectDelete(pixrect, &lclerr);
```

```
            EERR_DELETE( lclerr );
            pixrect = NULL;
      }

      return rval;
}
```

Code Snippet (Sec7_08): browsetool.eml

```
/*
******************************************************************************
**
**    browsetool.eml
**    This EML will be parsed by application (i.e., browsetool.exe)
**
******************************************************************************
*/

component browsetool
{
      frame frm_browsetool;
      frame frm_AddImgToCell;

/*
******************************************************************************
**
**    FRAME
**
******************************************************************************
*/    frame frm_browsetool
      {
            title "Acquire Image Information";
            geometry 0, 0, 550, 480;
            resizable;


            /*
            ** FRAMEPART FORWARD DECLARATION
            */
            group grp_ViewInfo;
            button btn_ViewConnection;
            edittext edt_ViewerID;
            label lab_ViewerName;

            group grp_SelectorInfo;
            button btn_CreateSelector;
            label lab_MapCoordinate;
            cellarraypart cel_Browseinfo;
            #generic cel_Browseinfo;
            button btn_cancel;
            variable getviewreturn;
```

```
statusbar;

/*
******************************************************************************
**
**    MENU & TOOBAR
**
******************************************************************************
*/
menu menu_File    "File"
{
      menu_File_AddImgToCell "Add Images to Cellarray..."
            info "Add Images to Cellarray..."
            display frm_AddImgToCell;

      menu_File_Close   "Exit..."
            info "Exit Browsetool"
            dismiss();
}

toolbar
{
      button btn_AddImgToCell
      {
            icon "catalog_image.icon";
            info "Add Images to Cellarray...";
            on mousedown
            {
                  display frm_AddImgToCell;
            }
      }
}

/*
******************************************************************************
**
**    GROUPs
**
******************************************************************************
*/
group grp_ViewInfo
{
      geometry 10, 10, 530, 120;

      /* INK TO ACTIVE VIEWER  */
      button btn_ViewConnection #openview
      {
            geometry 10, 10, 210, 40;
            title "Select Viewer";
            on mousedown
            {
                  set getviewreturn = getview();
                  set edt_ViewerID = fname($getviewreturn[1]);
                  set lab_ViewerName = $getviewreturn[2];

                  enable grp_SelectorInfo;
            }
      }

      /* WHERE THE VIEWER ID # WILL BE DISPLAYED  */
      edittext edt_ViewerID  #currviewtext
```

```
	{
		geometry 10, 60, 210, 50;
		title left top "Current Viewer # is:";
		readonly;
	}

	/* WHERE THE IMAGE NAME WILL BE DISPLAYED */
	label lab_ViewerName   #imagename
	{
		geometry 230, 60, 210, 50;
		title left top "Image Name is:";
	}
}


group grp_SelectorInfo
{
	geometry 10, 140, 530, 330;
	button btn_CreateSelector #getpoint
	{
		geometry 10, 10, 210, 40;
		title "Create Selector";
		on mousedown
		{
			pickpt();
			disable btn_ViewConnection;
		}
	}

	/* WHERE THE MAP COORDINATE WILL BE DISPLAYED */
	label lab_MapCoordinate #pointlocation
	{
		geometry 10, 60, 450, 50;
		title left top "Current Map Coordinate:";
	}

	/* ADD CELLARRAY HERE! */
	cellarraypart cel_Browseinfo
	#generic cel_Browseinfo
	{
		geometry 10, 120, 510, 200;
		lock left, right, top, bottom;
		info "Images to compare";
	}

}

/* THIS DUMMY BUTTON WILL ENABLE THE EXIT ICON */
button btn_cancel
{
	size 0,0;
	title "Close";
	on mousedown
	{
		dismiss();
		unload;
	}
}

on framedisplay
{
```

```
                disable grp_SelectorInfo;
            }
        }# CLOSE OF FRAME

/*
*****************************************************************************
**
**    FRAME
**
*****************************************************************************
*/
        frame frm_AddImgToCell
        {
            title "Selet Image to Cellarray";
            modal;

            filename fln_Imagefile;
            button btn_Add;
            button btn_cancel;
            variable imagecopy;


            filename fln_Imagefile
            {
                geometry  10, 10, 300, 400;
                title "Add Image to CellArray";
                select getpref("eml" "default_data_path") + "/*.img";
                filetypedef "raster";
                on valuechanged
                {
                    if ($fln_Imagefile == "")
                        disable btn_Add;
                    else
                        enable btn_Add;
                }
                on doubleclick
                {
                    send mousedown to btn_Add;
                }
            }

            button btn_Add
            {
                geometry 320, 10, 50, 40;
                title "Add";
                rightof fln_ImageFile;
                on mousedown
                {
                    set imagecopy = $fln_Imagefile;
                    addimage($imagecopy);
                }
            }

            button btn_cancel
            {
                geometry 320, 60, 50, 40;
                title "Close";
                below btn_Add;
                on mousedown
                {
                    undisplay frm_AddImgToCell;
```

```
                }
            }
            on framedisplay
            {
                disable btn_Add;
            }
        }
/*
*****************************************************************************
**
**    COMPONENT PROCEDURE
**
*****************************************************************************
*/
        on startup
        {
            display frm_browsetool;
        }
}
```

Running the Final Application

Work through the steps below to build and interact with your application.

1. Compile and run the application. If you run into errors, work through them using the capabilities of the Microsoft Visual Studio editor.

2. Click Setup, click **Select Viewer**, and select a **Viewer** containing an image.

3. Click **Create Selector**, and move the point around.

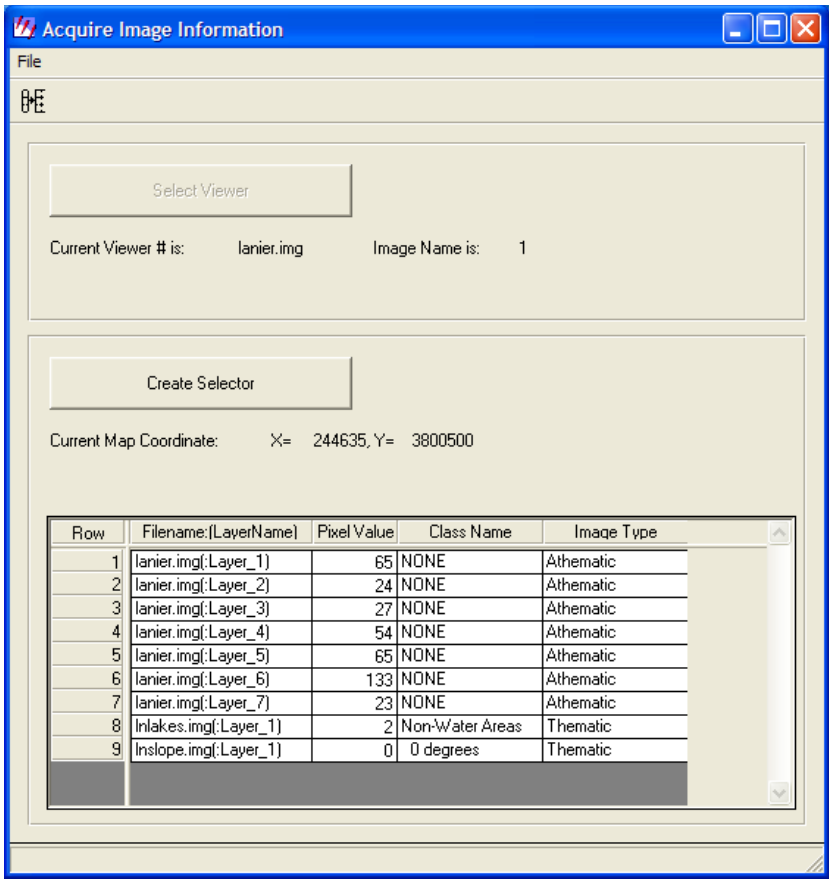
4. Select the **addimage** button, and notice the interface.

5. Select **lanier.img**, and click **Add**.

6. Select **lnlake.img**, and click **Add**.

7. Select **lnslope.img**, and click **Add**. Notice the updates in the **CellArray**.

8. Move the selector around in the **Viewer**. Notice the **CellArray** is being updated.



Congratulations! You have completed the development process of your application. This application can be extended to include numerous other functionalities. What you have learned will provide you with a solid foundation to build any application.

Class Notes:

Reference

Eimg_LayerOption

All options that appear in the variable-length argument for the function **eimg_LayerOpen** may be found at emun type **Eimg_LayerOption** in **eimg.h**:

Arguments	Description
EIMG_LAYER_OPTION_END = 0,	End of option list, no additional arguments.
EIMG_LAYER_OPTION_COMPRESSION_TYPE,	Compression type: 1 additional argument (Edms_CompressionType) which specifies the type of compression to be used.
EIMG_LAYER_OPTION_BLOCK_SIZE,	Size of each pixel block stored on disk for this layer: 2 additional arguments (int, int) which specify the width and height (in pixels) of each layer block.
EIMG_LAYER_OPTION_READONLY,	Allow only read-only access: no additional argument
EIMG_LAYER_OPTION_NUM_PHY_BLOCKS,	Number of physical blocks for virtual memory system: 1 additional argument (int) which specify the number of physical blocks to use for this layer.
EIMG_LAYER_OPTION_WINDOW,	Windows for the data in this layer: 1 additional argument (Eimg_Windows *) which specifies a rectangular window to use when reading and writting pixels of this layer. IMAGINE will not write pixels outside this region. When IMAGINE is requested to read pixels outside this region, these pixels are filled whith the boundary value. This value is initially zero, but can be modified via the EIMG_LAYER_OPTION_BOUNDARY_VALUE.
EIMG_LAYER_OPTION_BOUNDARY_VALUE,	Specify out-of-bounds value: 1 additional argument (Eimg_PixelRect *) which points to an Eimg_PixelRect structure containing the value to use when reading pixels outside the valid window. The value in the Eimg_PixelRect structure can be of any pixel type--IMAGINE will convert the value to the type of data stored in this layer. This window is initialialized to be the entire layer, but can be modified via the EIMG_LAYER_OPTION_WINDOW option.
EIMG_LAYER_OPTION_COMPUTE_STATS_ON_CLOSE,	Recompute layer statistics and store them on disc when the layer is closed: no additional arguments.

EIMG_LAYER_OPTION_OPEN_DEFAULT_TABLE,	Open default table for this layer: 1 additional argument (char *) with specifies the name of the new table to use. IMAGINE will seach for a table of this name which is a child of the layer (in the tree-structured IMAGINE file). The table must aleady exist, this option will not create it.
EIMG_LAYER_OPTION_CREATE_DEFAULT_TABLE,	Create default table for ttis layer: 3 additional arguments (char *, long, Edsc_BinFunction *) which specify the name of the new table to use, the number of rows in the table, and a pointer to a bin function. IMAGINE will create a table of this name which is a child of this layer (in the tree-structured IMAGINE file). The table must not already exist, this option will not overwrite an existing table. The symbol EIMG_DEFAULT_TABLE_NAME is recommended as the name of the main table for a layer. If the bin function is NULL, IMAGINE will create a default bin function for you which is determined from the pixel type of the layer data and the number of rows in the table.
EIMG_LAYER_OPTION_POLYTRANS,	Apply polynomial transformation when reading data from this layer: 3 additional arguments (Efga_Polynomial *, Eirf_InterpolationType, Eimg_PixelRect *) whichc specify the transformation, type of interpolation (e.g., bilinear), and the buffer which will be used to receive the data. The Transformation should be constructed such that when it is applied to a coordinate in the transformed coordinate system, a coordinate in the file coordinate system of the layer can be derived. Specifying the buffer is necessary so that addequate temporary storage (used to perform the transformation) will be preallocated. If the transformation is NULL, no transformation will be used when reading pixels from the layer.
EIMG_LAYER_OPTION_COMPUTE_COVMATRIX_ON_CLOSE,	Recompute convariance matrix and store it on disk when the layer stack is closed: no additional arguments.
EIMG_LAYER_OPTION_NO_RESCALE,	Do not rescale data when read: no additional arguments. IMAGINE can automatically rescale the layer data as it is read. Using this option disable rescaling. NOTE: Rescaling is mutually exclusive with any other radiometric transformation option.
EIMG_LAYER_OPTION_RESCALE_LINEAR,	Use linear rescaling when data is read: 2 additional arguments (Egda_Double, Egda_Double) which specify the **slope** and **offset** of the linear rescaling function. The value returned during a read operation, read_pixel is computed from the pixel value stored on disc, disc_pixel, using the following relationship: read_pixel = (slope * disc_pixel) + offset
EIMG_LAYER_OPTION_PROGRESS_METER_ON_CLOSE,	Print progress during statisitcs computation when layer is closed: 1 additional argument (Emet_MeterInfo *) whichc sepcifies the state filed

	to use for the progress meter and the minimum and maximum percentage numbers to print at the begining anad end of the statistics computation.
EIMG_LAYER_OPTION_DEFAULT_BIN_FUNCTION_STRUCTURE,	Specifies properties of default bin function to use for this layer: 1 additional argument (Erga_DefaultBinfStruct *) which contains the default properties to be used.
EIMG_LAYER_OPTION_VIEWER_INFO,	Specifies information used when a IMAGINE Viewer is displaying a layer as data is written into it: 1 additional argument (Eimg_ViewBlockInfo *)
EIMG_LAYER_OPTION_COMPUTE_SUBSAMPLED_IMAGES_ON_CLOSE,	Recompute subsampled images and store them on disc when the layer is closed: no additional arguments.
EIMG_LAYER_OPTION_EHFA_NODE_TYPE,	Specifies tte ehfa node type to use when creating this layer: 1 additional argument (char *)
EIMG_LAYER_OPTION_CONVOLUTION,	Specifies the convolution filter kernel to apply when reading data from this layer: 2 additional arguments (Eimg_Kernel *, Eimg_Window *).
EIMG_LAYER_OPTION_STATS_IGNORE_ZEROS,	Indicates that zeros should be ignored when computing statistics: no additional arguments.
EIMG_LAYER_OPTION_STATS_IGNORE_VALUE,	Indicates that a specify value should be ignored when computing statitiscs: 1 additional argument (Egda_BaseData *)
EIMG_LAYER_OPTION_NON_INITIALIZED_VALUE,	Specifies the value to return when reading raster data which has not been previously written to: 1 additional argument (Egda_BaseData *)
EIMG_LAYER_OPTION_NO_DMS,	This option indicates that the layer is not to be truly opened; the virtual memory system is not activated. This option is used as a quick method to find out certain information about the layer without truly opening it: no additional argument.
EIMG_LAYER_OPTION_DO_NOT_COMPUTE_SUBSAMPLED_IMAGES_ON_CLOSE,	Don't compute subsampled images and stores them on disc when the layer is closed: no additional arguments.
EIMG_LAYER_OPTION_BOUNDARY_TYPE,	Specify how to handle out-of-bounds values: 1 additional argument (Eimg_BoundaryType) which indicates how to determine pixel values when reading pixels outside the valid window. This window is initialized to be the entire layer, but can be modified via the EIMG_LAYER_OPTION_WINDOW option.
EIMG_LAYER_OPTION_SET_AOI,	Register an area-of-interest (AOI) to use when reading and writting layer data: 1 additional argument (Eaoi_AreaOFInterestHandle) which defines the area of interest.
EIMG_LAYER_OPTION_AOI_IGNORE_VALUES,	Specify a list of pixel values which are considered to

	indicatee out-of-bounds area. This is one method to establish an area-of-interest (AOI): 1 additional argument (Egda_Table *) which contains the list of values to be ignored.
EIMG_LAYER_OPTION_AOI_USE_BOUNDARY_VALUE,	Substitue the boundary value for pixels which are outside the AOI: no additional argument.
EIMG_LAYER_OPTION_USE_SS_LAYERS,	Use subsampled layers whenever possible when reading data through a reducing transformation: no additional argument.
EIMG_LAYER_OPTION_AOI_DO_NOT_USE_BOUNDARY_VALUE,	Do not substitute the boundary value for pixels which are outside the AOI: no adddtional arguments.
EIMG_LAYER_OPTION_DO_NOT_USE_AOI_ON_NEIGHBORHOOD,	Apply mask from layer during eimg_LayerStackArrayApplyNeighborhoodFunction Block.
EIMG_LAYER_OPTION_COMPUTE_SUBSAMPLED_LAYERS_ ALGORITHM,	Specify which resampling algorithm to use for computing subsampled images: 1 additional argument (Eimg_SSAlgorithmType)
EIMG_LAYER_OPTION_STATS_SKIP_FACTORS,	Skip factors to use when computing statistics: 2 additional arguments (int, int) which specify the skip factors in the x and y directions, respectively.
EIMG_LAYER_OPTION_COMPUTE_STATS_ON_FLY,	Compute statistics on pixel blocks as they are actually written to disc.
EIMG_LAYER_OPTION_DO_NOT_COMPUTE_STATS_ON_FLY,	Don not computes statistics on pixel blocks as they are actually written to disc.
EIMG_LAYER_OPTION_COMPRESSION_TYPE_NAME,	Compression type name: 1 additional argumente (char *) which specifies the type of compression to be used. The compression should be legal for the file.
EIMG_LAYER_OPTION_PROCESS_RAW_DATA,	Process raw data: 1 additional argument (Emsc_Boolean) which indicates whether the data should be returned from eimg_LayerRasterPixelRectGet as a copy of the file bytes (EMSC_TRUE) or in a form that is equivalent to the Egda_PixelType's (EMSC_FALSE).
EIMG_LAYER_OPTION_RRD_EXTENSION,	RRD Extension: 1 additional argument (char *) which indicates the extension (and thus the file format) to use to store reduced resolution datasets. If the extension is NULL, the RRD's will be stored in the same file as the imagery.
EIMG_LAYER_OPTION_NUM_UNDO_LEVELS,	Number of undo levels: 1 additional argument (int) which indicates the number of transactions on the raster data in the layer that are undo-able. 0 (the default) allows direct writing to the files. -1 allows unlimited undos. A positive integer allows that many undo-able transcations.

EIMG_LAYER_OPTION_GEOMETRIC_TRANS,	Apply an arbitrary geometric transformation when reading data from this layer: 2 additional arguments (Exfr_XForm *, char *) which speccfy the transformation and type of resampling method used to transform the data. The transformation should be constructed such that when it is applied to a coordinate in the transformed coordinate system, a coordinate in the file coordinate system of the layer can be derived. The resampling method can be any of the resampling methods available for the Exfr_XForm (see [*eirf_ResampleMethodsGet*]) If the transformation is NULL, no transformation will be used when reading pixels from the layer.
EIMG_LAYER_OPTION_ERROR_IF_NONEXISTENT,	Return an error if a layer is non-existent when an open is performed 1 additional argument (Emsc_Boolean) which specifies whether an error should be returned and processing should be aborted. The default is EMSC_TRUE. If the option is EMSC_FALSE, the returned layer will be NULL (which means you may have NULL layers in a layer stack if you use this option on a layer stack open)
EIMG_LAYER_OPTION_USE_PRIVATE_STORAGE,	Use private copies of all allocated wwrk areas. This option takes 1 additional argument (Emsc_Boolean) which specifies whether or not private storage should be used to perform calculations during eimg_LayerRead functiton calls. The layers that have this option set to EMSC_TRUE may use eimg_LayerRead calls. During the eimg_LayerRead calls of different layers (i.e., recursively) at the expense of increased data storage requirements for that layer. Any layers that have this option set to EMSC_FALSE must not be used with any eimg_LayerRead calls while in the midst of any eimg_LayerRead call.
EIMG_LAYER_OPTION_RETAIN_LAYERSTACK_RESAMPLEDATA,	Retain resample data storage on a layer stack. This option takes 1 additional argument (Emsc_Boolean) which specifies whether or not the resample storage associated with a layer stack should be retained between successive calls to eimg_LaaerStackRead for efficiency. This is usually only possible when all operations to the layers in the layer stack are performed solely through eimg_LayerStack function calls so that the eimg package has the opportunity tt maintain the resample storage properly. The default is EMSC_FALSE.
EIMG_LAYER_OPTION_APPLY_BIN_FUNCTION,	Apply a bin function when reading raster data. This option takes 2 additional arguments (Edsc_BinFunction *) which performs the bining and (Eimg_BinUndefinedRule) which controls what pixels values are to be used when bining results in an error or undefined bin. NOTE: Bining is mutually exclusive with any other radiometric tranformation option.
EIMG_LAYER_OPTION_NAME_PARAMETER_CORRECT_	Plug in funcitons taht allow a user to be prompted when data associated with the image layer (via a file

FUNCTIONS,	system object reference) can not be located. This option takes 3 additional arguments: (Efio_FileNameVerifyFunction, Efio_FileNameLocateFunction, Emsc_Opaque *) see efio_FileNameCorrect.
EIMG_LAYER_OPTION_CUSTOM_PIXEL_PROCESSOR,	Plug in functions that allows performing custom image processing on a block of pixels. The option takes five additional arguments: (img_PixelRectStackProcessorFunc pFunc, Eimg_PixelRectStackDeterimineInputFunc dFunc, void *userData, Eimg_UserDataFreeFunc fFunc, long *cookie)
EIMG_LAYER_OPTION_DATA_ORDER,	Order in which bands should be read or written for most efficient disk access. 2 additional arguments (RasterDataOrder supportedDataOrders, RasterDataOrder * pDataOrder), the first argument is bitfield indicating which orders the applicataon is able to process in. The second argument is passed back to the applicaiton indicating the order that is perferable to use. The application must then use the order that is passed back.
EIMG_LAYER_OPTION_USE_APPLICATION_OWNED_PRIVATE_STORAGE,	Use external private storage provided by application. Ttis option takes 1 argument (Eimg_PrivateStorage *) which specifies that the layer must use work area provided by the application. The default is to use internal private storage.
EIMG_LAYER_OPTION_USE_SHARED_CACHE,	Use shared cache provided by application. This option takes 1 additional argument (Eimg_SharedCache *) which specifies that the layer must use cache provided by the application.
EIMG_LAYER_OPTION_SS_LAYERS_RESET,	Reset subsampled layers, no additional arguments.
EIMG_LAYER_OPTION_DO_NOT_USE_SS_LAYERS,	Do not use subsampled layers when reading data, no additional arguments.
EIMG_LAYER_OPTION_DO_NOT_APPLY_MTFC_CORRECTION,	Do not apply MTFC correction when reading data, no additional arguments.
EIMG_LAYER_OPTION_USE_APPLICATION_OWNED_DMS,	Use external DMS cache provided by application. This option takes 1 additional argument (Emsc_Cache *) which specifies that the layer must use DMS cache provided by the application. The default is to use internal DMS per layer.
EIMG_LAYER_OPTION_RASTER_QUALITY	This image quaaity desired when reading the image pixels. This option takes 1 additonal argument (double) which specifies the desired quality as a percentage in the range of 0.0 to 100.0, where 0.0 quality is defined by the implementation.

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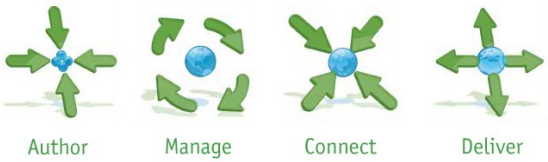

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